VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

Published by

THE INDUSTRIAL PRESS
Also publishers of MACHINERY and technical books

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Publishing Information

HEATING AND VENTILATING is published monthly by The Industrial Press at 148 Lafayette Street, New York 13, N. Y. Yearly subscription in the United States, Spain, South America, Mexico, and Canada, $2.00; in all other countries, $3.00. Single copies 30 cents. Entered as second class matter, April 18, 1925, at the Post Office, New York, N. Y., under the act of March 3, 1879.

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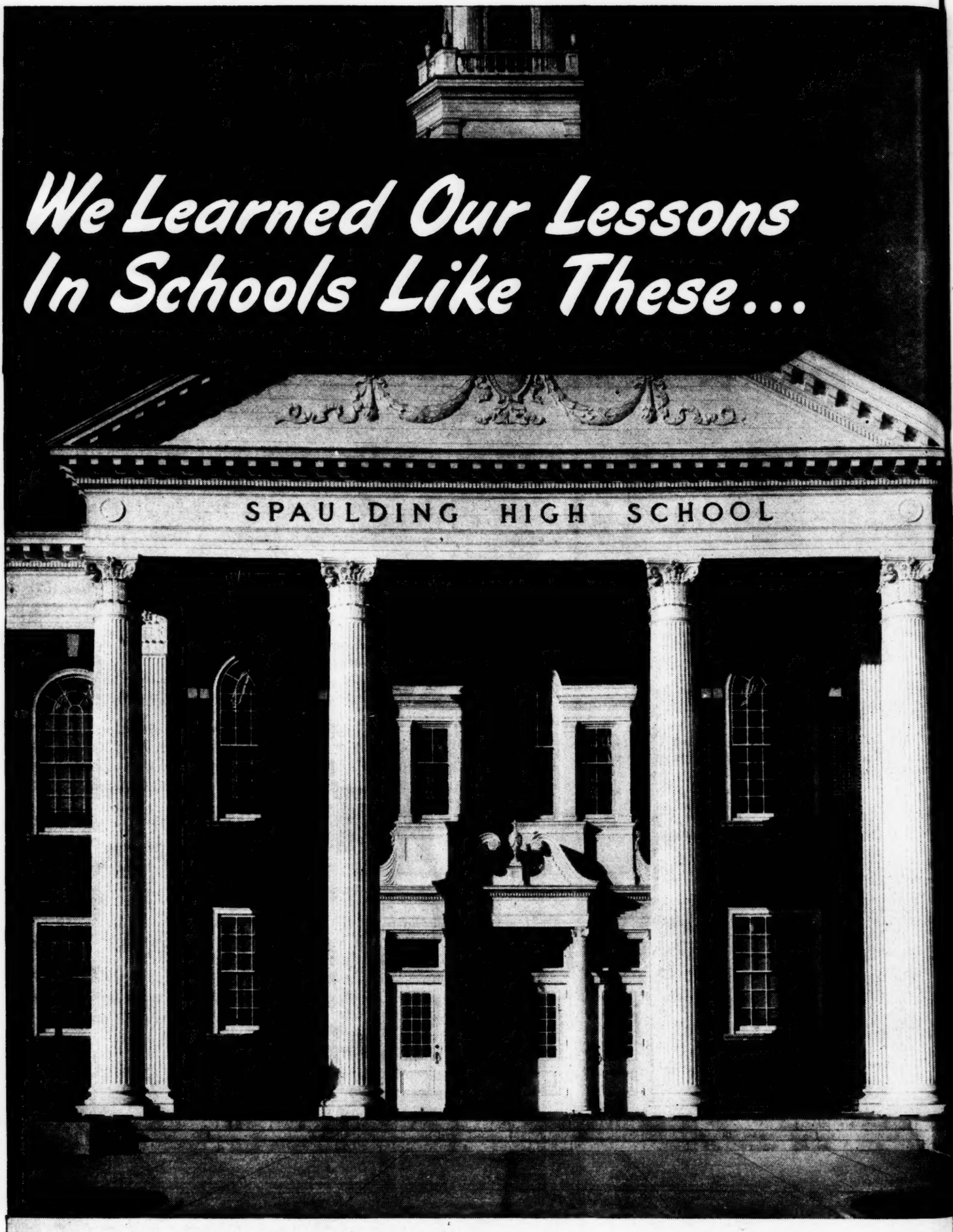
MEMBER
Audit Bureau of Circulation
Associated Business Papers

THIS MONTH'S COVER

Photograph, taken by Joe Rosenthal of the Associated Press, shows Marines of the 28th Regiment of the Fifth Division raising the flag atop Mount Suribachi on Iwo Jima.



One of the last and most modern schools to be completed before the war is Spaulding High School, in Rochester, New Hampshire. This beautiful building cost over $1,000,000 and Sturtevant Equipment was installed throughout—to handle 520 tons of air per hour: Heating and Ventilating Engineers, A. B. Franklin Co., Boston; Heating and Ventilating Contractors, M. J. Flaherty Co., Boston.

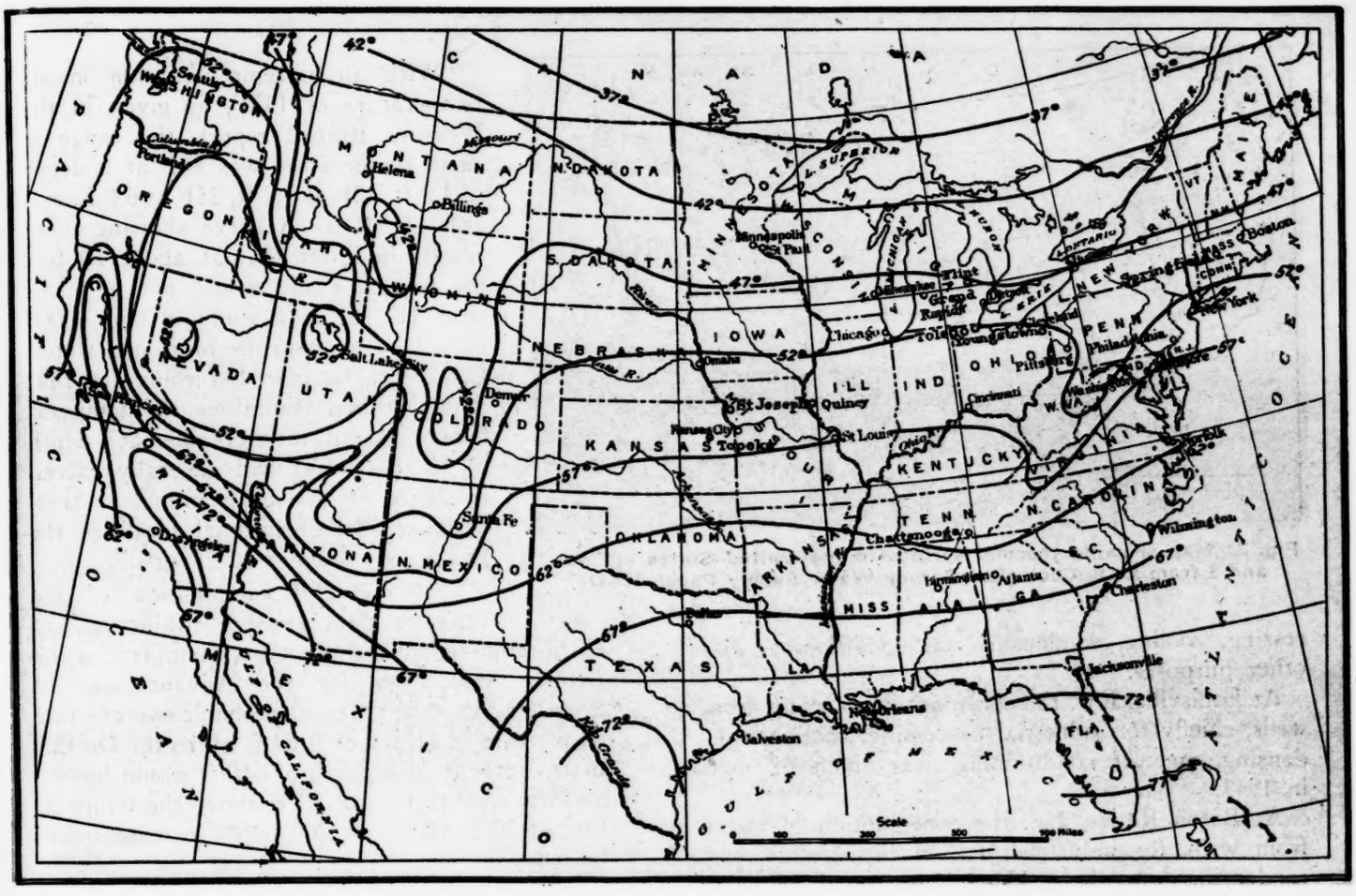


Fig. 1. Map of the United States showing approximate temperature of water from nonthermal wells at depth of 30 to 60 ft. (From U. S. Geological Survey Water Supply Paper 520-F)

Effect of Air Conditioning Demand on Well Water Availability

V. T. STRINGFIELD

Senior Geologist, Geological Survey, United States Department of Interior

GROUND water generally has an almost constant temperature and quality, with temperature lower than that of surface water in summer time. Also in many areas, ground-water supplies can be developed quickly at a relatively small cost. These features make ground water desirable for industrial use, especially for processing, cooling, condensing, and air conditioning. Under these conditions many increases in use of air conditioning for comfort in public places and homes, and for control of industrial processes in factories, have led to required increases in the consumption of ground water. Because large quantities of water are essential for many industries, the increase in industrial development has required large increases in water consumption, out of proportion to the population increases. For example, the consumption of ground water for one industrial plant in northeast Florida has increased recently by 30 million gallons a day (mgd), which would supply a city with a population of 300,000 and a per capita consumption of 100 gallons a day.

Among the many industrial areas in which large quantities of ground water are used for cooling, condensing, and air conditioning are Long Island, N. Y., Memphis, Tenn., Louisville, Ky., Baton Rouge, La., and Indianapolis, Ind.

Ground water pumpage on Long Island, exclusive of pumpage from numerous small domestic wells, averaged about 260 mgd in 1942. During that year about 55 mgd was pumped from wells for industrial and cooling purposes in western Long Island. A report by Brashears indicates that during the summer of 1944 about 60 mgd was pumped from wells for cooling and also for similar purposes on Long Island.

In the Memphis, Tenn., area, the average quantity of water pumped from wells in 1943 was about 115 mgd. Less than 30 mgd was for the public supply and more than 85 mgd was used for industrial pro-

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Fig. 2. Map showing thermal springs in the United States. (Figs. 2 and 3 from U. S. Geological Survey Water Supply Paper 836-D)

cessing, cooling, condensing, air conditioning, and other purposes.

At Louisville, Ky., the consumption of water from wells, chiefly for industrial processing, cooling, condensing, and air conditioning, was about 62 mgd in 1943.

At Baton Rouge, La., the consumption of water from wells for industrial use, chiefly cooling and condensing, was about 50 mgd during the summer of 1944, when water from the Mississippi River was too warm to be suitable for cooling purposes. Consumption from wells was somewhat less during the winter when water from the river was used to supplement the supply.

In the Indianapolis, Ind., area, the consumption of water from wells was about 47 mgd in 1942. About 38 mgd was used for industrial processing, cooling, and air conditioning.

During the present war additional ground-water supplies have been developed throughout the country for war plants, and the consumption at many of the existing plants converted to war use has been increased. After the war the consumption of water for war plants will decrease. However, it is expected that the total consumption of ground water not only for industrial use but for municipal, irrigation, and domestic supplies will increase with post-war activities and industrial development.

Temperature and Chemical Composition of Ground Water

Temperature of water from wells in many parts of the country is given in reports on the ground-water resources. In general, the temperature of the shallow ground water is slightly higher than the mean annual temperature of the atmosphere.

Near the land surface the temperature of the ground water fluctuates with changes in the temperature of the atmosphere. However, the fluctuations decrease rapidly within the first few feet of depth. At greater depths the water has a higher temperature corresponding to the temperature increase of the earth with increasing depth.

As stated in a report by Collins[1]:

"With an extreme variation in air temperature of 133F, as given in the Weather Bureau report, the range in earth temperature was 80F at a depth of 1.2 ft, 42F at 3.7 ft, 25F at 6.6 ft, and 18F at 9.0 ft. A curve showing these results indicates that at about 30 feet the annual range would not be more than 1F. From a study of over 3,000 records of temperature of ground water, C. E. Van Ostrand has computed that under normal conditions the temperature of ground water obtained at a depth of 30 to 60 feet will generally exceed by 2F or 3F the mean annual air temperature. In exceptional localities the excess may amount to 5F or 6F.

"After careful examination of the available data relating to increase of earth temperature with depth, a committee of the British Association for the Advancement of Science adopted as the most probable average rate an increase of 1F for each 64 ft of depth. On this basis, water from a depth of 640 ft would have a uniform temperature of 10 F above the temperature at 30 or 60 ft. At 200 ft the increase would be only 3F.

"It may be stated, then, for practical purposes that a ground-water supply obtained at any depth from 20 to 200 ft will have a uniform temperature ranging from about 3 to 6F above the mean annual air temperature. If the supply comes from a depth more than 300 ft, the difference in temperature due to increased depth must be taken into account."

On the basis of more recent data the normal gradient in the first 1,000 feet of sediments is somewhat more than 64 feet for each change in temperature of 1F.

The probable temperature of ground water at depths of about 30 to 60 feet in the United States is shown in Fig. 1. The figure is based on a map of the United States Weather Bureau showing the mean annual temperature of the atmosphere at or near the land surface. Since temperature of shallow ground water is somewhat higher than the mean annual temperature of the atmosphere, temperatures shown on the map are two degrees higher than those on the map of the Weather Bureau showing the mean annual temperature of the air.

Exceptions to this generalization occur in areas where the ground water is influenced by local geologic conditions. Also, where large recharge from surface streams occurs, the temperature of the ground water is influenced by the temperature of the surface streams. As shown in a report at Parkersburg, W. Va., where the water-bearing formations receive recharge from the Ohio River, the temperature of the well water ranges approximately from 46 to 66F during the year.

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[1]Collins, W. D., Temperature of Water Available for Industrial Use in the United States: U. S. Geol. Survey Water-Supply Paper 520-F, p. 98, 1925.

Some areas in which the geologic conditions cause the ground water to have a higher temperature than would be indicated by the normal geothermal gradient are discussed in a report by Stearns, Stearns, and Waring[2]. They stated:

"There are two main phases of the problem of the origin of thermal springs, namely, the sources of the water and the sources of the heat.

"The water may be meteoric—that is, surface water which has percolated downward, been heated, and then ascended to the surface; it may be juvenile—that is, a product from the magna itself which has reached the surface for the first time; or it may be a mixture of meteoric and juvenile water in any proportion.

"The heat of the thermal springs may be derived (a) from the natural increase in temperature of the earth with depth, (b) from an underlying body of hot or possible molten rock, (c) from zones where there has been faulting of the rocks with resultant development of heat, (d) from chemical reactions beneath the surface, or (e) from the energy derived by disintegration of radioactive elements.

"In most areas where the rocks have been little disturbed, the records obtained from deep wells and mine shafts show that the temperature increases 1F for about each 40 to 90 ft increase in depth. Hence, surface water that penetrates to a depth of 1,000 feet may have its temperature increased perhaps 20F; and if it rises fairly rapidly to the surface again, it may issue at a temperature noticeably higher than normal. Such a condition is believed to account for the warm temperature of certain springs in Virginia.

"The warmth of most deep-well waters is due to this natural increase of temperature of the earth with depth. Many springs, known as artesian springs, discharge water warmed by contact with warm rocks at the depth to which the water has penetrated.

". . . In many places, large bodies of hot rock lie at shallow depths but do not give off appreciable quantities of magmatic water. For example, the amount of steam given off by a body of hot rock at shallow depth at Kilauea Volcano, Hawaii, is negligible except immediately after rains. At Klamath Falls, Oreg., it is a common practice to drill shallow holes to the hot rock and insert coils through which water is circulated for heating. These holes do not steam, and yet surface water introduced into them is promptly heated and returned by convection to the surface. The major part of the discharge of the hot springs near Klamath Falls is doubtless meteoric water circulating through cracks in a similar way."

[2]Stearns, N. D., Stearns, H. T., and Waring, G. A., Thermal Springs in the United States: U. S. Geol. Survey Water-Supply Paper 679-B, 1937. Includes references to previous reports on the subject.

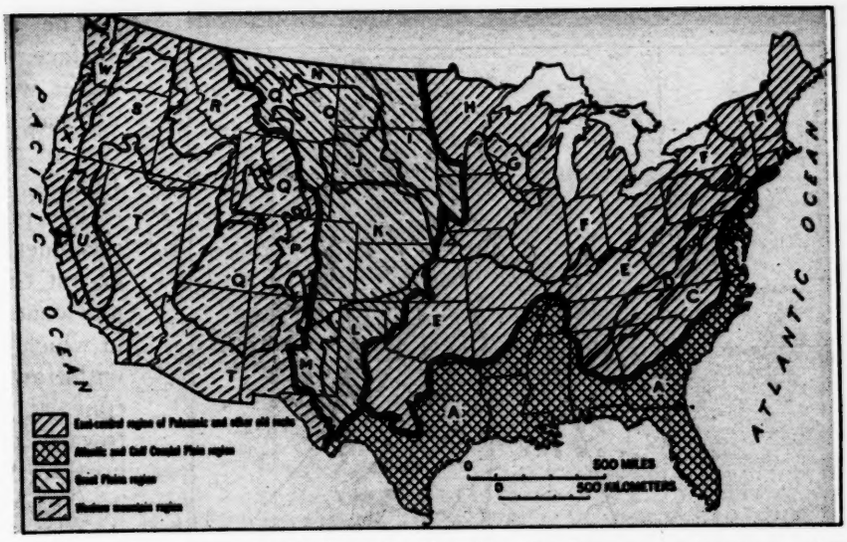


Fig. 3. Map of the United States showing the four major regions with respect to ground water provinces and subdivisions.

Fig. 2 shows the distribution of thermal springs in the United States.

Ground water generally is uniform in composition throughout the year. Analyses showing the chemical composition of ground water and indicating the composition of the water that might be expected in the different water-bearing formations, are included in many of the reports on the ground-water resources.

Occurrence and Quantity of Ground Water

In order to develop an adequate ground-water supply, information must be obtained concerning the occurrence and quantity of the water available in the underground reservoirs. This is especially important because the large diversity in geology, topography, and climate have resulted in a corresponding large diversity in the underground reservoirs and the quantity of water available from them. Some areas are very productive and others yield only small supplies. Information concerning the perennial yield of the ground-water reservoirs is needed so that no supply, large or small, will be overdeveloped.

A comparison of the ground-water provinces in Fig. 3 shows major differences between provinces and indicates the more productive provinces. For example, ground-water province *A*, the Atlantic and Gulf Coastal Plain, is one of the most productive provinces in the United States, and province *C* is one of the least productive even though adjacent to province *A*. Many wells in parts of province *A*, as in Florida and Georgia, will yield several thousand gallons a minute, and some of the springs are the largest limestone springs in the United States. The flow of the largest of these, Silver Springs, near Ocala, Fla., has ranged from about 340 mgd to 800 mgd. Only exceptional wells in province *C* yield as much as a few hundred gpm. Such regional differences are very significant in selecting areas in which large supplies can be obtained from wells. Also within each ground-water province there are significant differences, as may be noted in some of the less productive provinces. In Ohio, Indiana, and Ken-

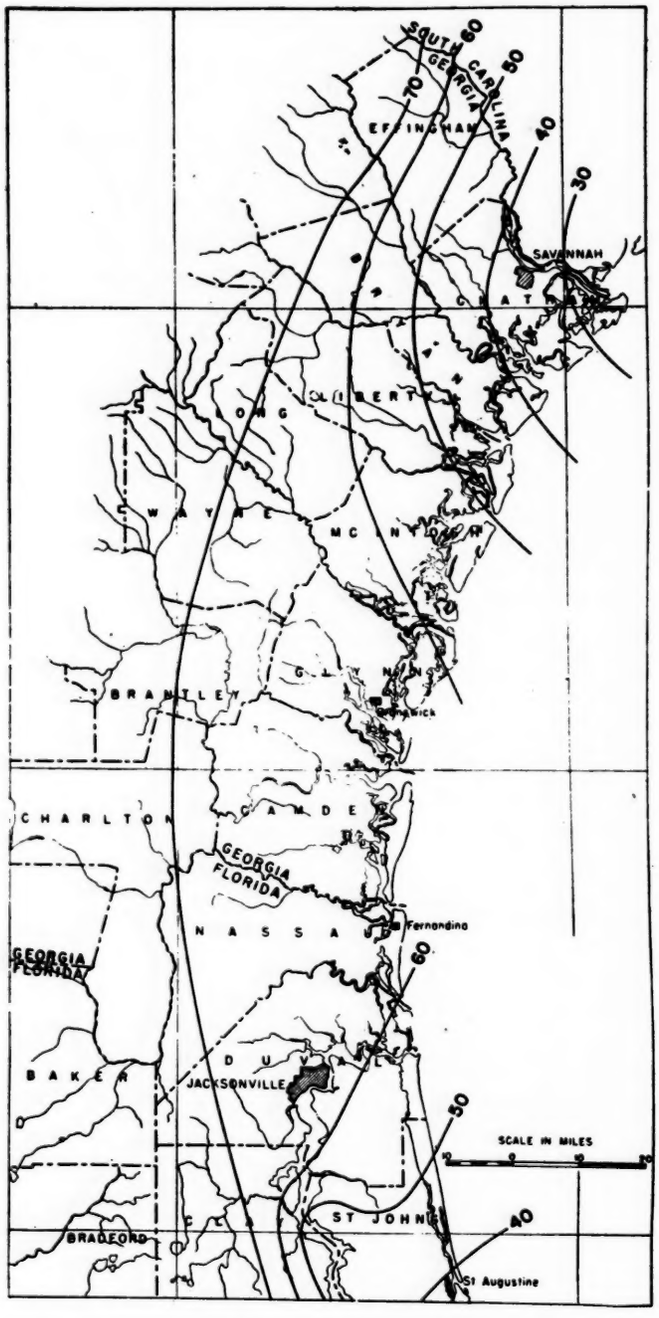


Fig. 4. Map representing the original piezometric surface of artesian water in the coastal area of Georgia and northeastern Florida, prior to about 1880.

tucky, province *E*, the consolidated rocks yield only small supplies but large supplies are available from sands and gravels which receive recharge from the Ohio River and other large streams.

Significant differences may also be present within areas underlain by the same formations, in which geologic conditions may be regarded as relatively uniform. For example, in the coastal area of Georgia and northeastern Florida, productive limestones which underlie all of the area have been developed in several locations for industrial use as shown in figures 3, 4, and 5. Although large yields can be obtained from wells in any part of the area, some parts are much more productive than others, as indicated in the following discussion.

The approximate elevation of the piezometric surface, which represents the height to which the water would rise in the first wells drilled into the artesian reservoir, is shown in Fig. 4, and the elevation of the piezometric surface in 1943 is shown in Fig. 5.

The piezometric surface in 1943 is similar to the piezometric surface when the first wells were drilled, except that its coastward slope has been steepened and cones of depression have been formed in areas in which large quantities of artesian water are being withdrawn. Prior to the development of the large cone at Savannah, the artesian water converged toward that area from the southwest, west, and northwest, indicating a discharge area off shore northeast and east of Savannah. As may be noted, the piezometric surface of the artesian water in 1943 was 70 ft or more above sea level in the western part of the coastal area and about 20 to 50 ft above sea level along the coast, except in the Savannah and Fernandina areas.

At Savannah, where the withdrawal of water is about 41 mgd, the piezometric surface is more than 30 feet below sea level and about 70 ft below its original level; and at Fernandina, where the withdrawal is about 34 mgd, the piezometric surface is at or near sea level and as much as 60 ft below its original level. In contrast, at Brunswick, although the withdrawal of water is about 37 mgd, the piezometric surface is about 45 ft above seal level and only about 20 ft below its original level; and at Jacksonville, where the withdrawal of water is about 40 mgd, the piezometric surface is about 30 ft above sea level and only about 30 ft below its original position. As the same formations yield water to the wells at each of these localities and the geologic conditions are similar, the differences in the shape and elevation of the piezometric surface indicate significant differences in the water-bearing capacity of the formations from place to place.

Overdraft from Wells

In some areas of heavy withdrawal from wells, ground water is being withdrawn in such large quantities that the problems of overdraft and safe yield are becoming urgent. These problems involve for each formation and each area the quantity of water in storage, the proportion of the stored water that can be recovered through wells, the average rate of natural intake or recharge, the proportion of recharge that can be recovered through wells, the effects of the withdrawals through wells upon water supplies derived from natural ground water discharge, and the extent to which the rate of recharge can be increased. In some of these areas of heavy withdrawal the water levels may be lowered greatly without exceeding the perennial yield, whereas in others the perennial yield may be exceeded with only a small decline, as in areas in which a decline will cause encroachment of salt water or will lower the water level to the bottom of the geological formation.

Water levels in wells necessarily decline in response to pumping or artesian flow, but if the withdrawal is not excessive the water levels will become relatively stabilized at some lower position and the supply will be perennial. However, if the withdrawal is excessive there will be a persistent decline in water levels until the lowest practicable pumping level is reached, after which the yield will gradually decrease until a balance between withdrawal and recharge is established.

Declines of water levels due to withdrawal of water from wells are relatively local and do not cause widespread lowering of the water table throughout the country. In many of the areas of heavy draft where the water levels have declined, investigations of ground-water conditions reveal that additional ground-water supplies are available, either in the same formations at moderate distances from the existing wells or in previously undeveloped formations at greater or less depth.

Additional Supplies Possible

Many examples, similar to the following, of additional supplies found by investigations can be cited. At Camp Claiborne, La., water levels in wells drilled for the camp supply declined rapidly and it was evident that a new source of supply was necessary. An investigation revealed that an abundant supply of water was available in another water-bearing formation underlying the camp. The supply from this new source has been more than adequate and is a potential resource for post-war use. At Alexandria, La., near Camp Claiborne, water levels were persistently declining in the city wells as the withdrawal of water from those and other wells in the area increased. On the basis of a ground-water investigation of the area, new wells were developed within a few miles of the old wells. At Natchitoches, La., the municipal ground-water supply from wells was becoming rapidly depleted. An investigation revealed a new source of water, in an area about 5 miles from the old wells, and a supply has been developed from that new source.

The fact that many sources of ground water have large supplies in storage, whereas others have only small reserves, emphasizes the need for adequate investigation of both old and new sources of supply before the old sources are seriously depleted. For example, overpumping at the western end of Long Island, New York, by industries and waterworks depleted the ground-water supply to such an extent that sea water moved into the water-bearing sand and gravel. The damage to the supply became so serious that in 1932 regulation of the ground-water supply was begun by the Water Power and Control Commission of New York. Adequate information on the ground water, obtained before the salt-water contamination occurred, would have shown the need for regulation in order to preserve the water supply and there would have been time to begin the regulation before the contamination occurred.

In addition to the development of new supplies and regulation and conservation of the supplies,

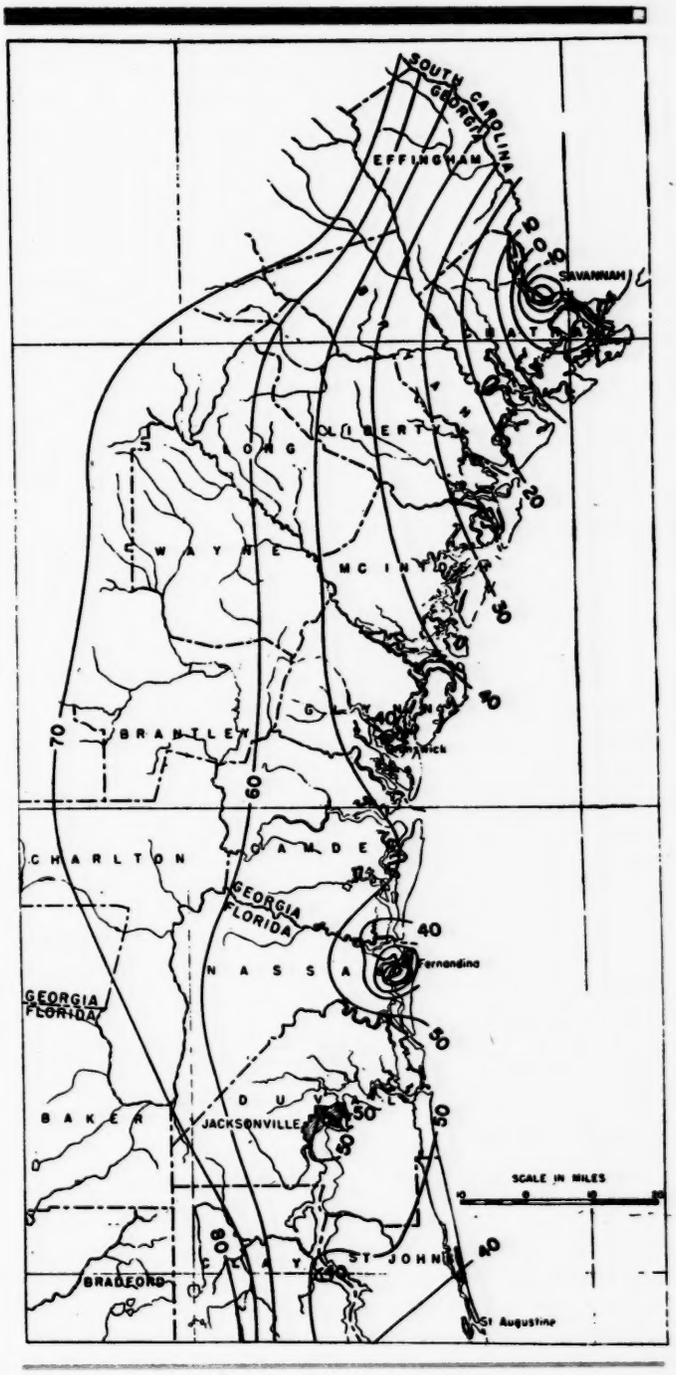


Fig. 5. Map representing the piezometric surface of artesian water in the coastal area of Georgia and southeastern Florida in 1943.

other remedial measures to insure adequate supplies and protect existing supplies include artificial recharge.

In some places recharge may be greatly increased by pumping from wells and thus making storage capacity available. However, the rate at which any group of wells can yield water perennially is limited by their ultimate cone of depression with maximum drawdown. Further utilization of the reservoir requires new wells beyond the cone of depression or artificial recharge within the area of influence of the cone.

In some places where water-table conditions exist, as in the Ohio River valley, large supplies have been obtained by locating wells near a stream

and developing a steep hydraulic gradient from the stream to the wells. Under artesian conditions, if the capacity of an artesian aquifer to transmit water to the wells under maximum drawdown is less than the potential recharge in the intake area, further utilization can be achieved only by recharge through wells penetrating the confining bed which overlies the aquifer, or by sinking production wells nearer the intake to steepen the hydraulic gradient.

Artificial recharge requires an effective process for getting the water into the aquifer—either by surface infiltration or through wells. The major requirement, in addition to a permeable terrane, is water that will not clog the intake or practicable means of clearing the intake periodically.

Recharging Terranes

In California artificial recharge by spreading water over permeable terranes is now practiced to a considerable extent. Wells have long been used in some limestone formations, as in Florida, to drain surface water into the limestone. In recent years wells have come into use to recharge the water-bearing formations. For example, in order to prevent further overdevelopment of the ground-water supply on the western end of Long Island, New York, regulation of the ground-water supply was begun by the New York State Water Power and Control Commission, which required that water pumped from new wells for cooling and similar purposes be returned to the ground. During the summer of 1944 more than 200 recharge wells and several recharge pits on Long Island, N. Y., were returning water to the water-bearing formations at the combined rate of about 60 mgd. Also in operation were several large recharge pits which return storm sewer runoff in Nassau County, Long Island. Recharge wells capable of returning as much as 1,000 gpm have been developed on Long Island and many of them have been in operation for more than five years without failing. Recharge pits in the coarse glacial gravels are capable of returning about one mgd per acre of exposed surface.

The temperature of the recharge water returned to the water-bearing formations on Long Island is higher than the normal temperature of the ground water, and thus creates the problem of raising the temperature of the ground water locally to such an extent that it may eventually become too warm for air conditioning and cooling purposes.

As stated previously, about 62 mgd of water was pumped from wells in 1943 for industrial processing, cooling, condensing, and air conditioning at Louisville, Ky. An investigation of the area indicated that the pumpage was more than 20 mgd in excess of the natural recharge to the glacial outwash sand and gravel in the area affected by pumping.

During the spring of 1944 two of the plants using water for cooling and condensing helped solve the local shortage of ground water by recharging the underground reservoir with 1.7 mgd of cold water from the municipal supply. While that water was being added to the aquifer through several supply wells, the plants were operated with water from the municipal supply. In that way the large cone of depression in the water table that had been created by heavy pumping from wells was largely filled with cold water from a combination of natural and artificial recharge. As a result, during the summer when the municipal water became too warm to be used in the industrial plants, an adequate supply of cold water was available from wells. If such recharge were practiced on a sufficiently large scale, it would not only stop the persistent decline of water levels in the Louisville area by making the recharge equal to the discharge, but would also permit wells to be pumped at much larger rates during the summer than would be possible if the wells are used continuously.

Similar practices may prove to be feasible in other parts of the country and experiments with artificial recharge should be considered wherever overdevelopment of the ground-water supply has occurred.

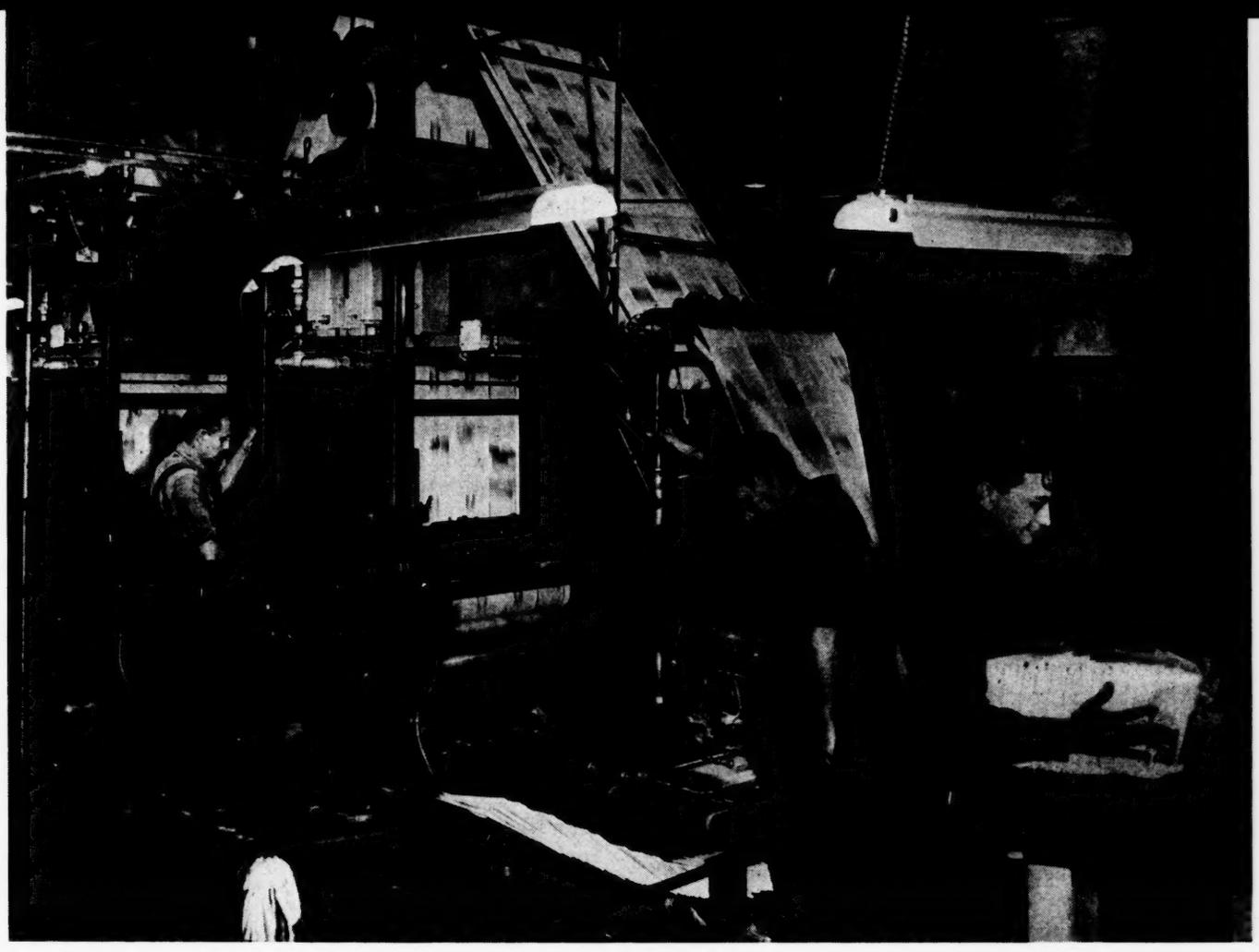
Construction Costs to Govern Post-War Market

Three major tests face the construction industry if it is to enjoy a sustained prosperity after the war, according to Thomas S. Holden, President of F. W. Dodge Corporation.

The first test will be whether the industry can get past the early revival period without a disastrous inflation of construction costs. The second will be whether the industry can progressively broaden its market by reducing costs after the period of inflation dangers is passed. The third test is whether the industry and those related influences which create construction demand can successfully control the boom.

"To the vast over-all problem of managing the transition to a peacetime economy, every element of the construction industry must try to contribute its maximum of intelligence, information and self-restraint," he said. "The post-war inflation threat will be the first major crisis the industry will have to meet.

"Even if the post-war inflation hazard is successfully passed, construction costs will still likely be a critical factor in determining the size of the construction market. A vast portion of the potential post-war market is in the field of low and moderate-priced houses, and other moderate-priced buildings. My guess is that the coming construction market will be more sensitive to price rises than was the speculative market of the 1920's and that it will, after the most urgent demands have been met, tend to shrink if construction costs appear very much out of line with general commodity prices and costs of living."



Gas-fired dryers installed on an offset press to dry the ink as paper passes at high speed through two facing burners which apply 1200F heat.

Speeding Time on the Pacific Coast

FRED A. HERR

GAS-FIRED ribbon burners with ceramic jets are used in a specially designed ink dryer to radiate heat onto printed paper rolling through an offset press at high speed and thereby produce instantaneous drying of the ink when the temperature is regulated to within a few degrees of the paper's scorching point. It has functioned successfully since it was installed in the printing plant of the Adcraft Co., Los Angeles.

It has speeded the printing and has improved the appearance of the weekly run of *Time* magazine's Pacific Coast edition, now printed in Los Angeles. The heater-dryer unit was specifically designed for this job.

Formerly printed in Chicago and shipped to California, *Time* for California distribution is now printed and bound in Los Angeles on paper manufactured on the Pacific Coast. The increased speed of the printing has been made possible by the new heating device. The press run has been stepped up from 130,000 copies weekly in January, 1944, to 175,000 copies in January, 1945.

Type for the news pages is set in Chicago, reproduced on cellophane transparencies, and flown to Los Angeles for printing. Two sets of cellophane transparencies of the news pages are flown by different air routes to Los Angeles. As an additional precaution, a third set is shipped by train for emergency use in case the other sets are lost in transit. The colored front and back covers come already printed, and plates for other color pages are flown to the west coast.

In addition to supplying Pacific Coast readers of *Time* with quicker delivery, the arrangement saves railroad shipping space. For this reason *Time's* plan of printing in California has been given the approval of both the WPB and the Office of Defense Transportation as it saves railroad shipping space.

Installation of the unit on the offset press followed prolonged experiments by the Selas Co., Philadelphia, in collaboration with Adcraft technicians, to learn how to speed up the printing of *Time* without smudging the pages. The edition is handled on two offset presses.

Early in 1944 it became apparent that some method was necessary for more quickly drying the

ink. As the larger of the two presses produces 12,000 copies per hour, at this speed pages would smudge during printing and the folding machine would become fouled by wet ink.

Heaters Speed Ink Drying

The problem called for a heat reacting ink together with a heating unit which would process the ink for instant drying. For the latter a method had to be devised for producing the proper heat and a system for regulating the heat in graduated volume so it could be applied to the web of paper without burning or scorching the paper as it passed through the press at high speed.

Normal oil-base ink, where drying is achieved by oxidation, was unsuitable because it took too long to dry. An ink with solvent properties was required, one composed of pigment in a solvent, which would remain stable at ordinary room temperature but which would permit the solvents to vaporize rapidly when heat was applied.

In the ink used for printing *Time* in the Adcraft Co.'s plant, the solvents remain stable on the press up to 150F without thinning and the ink retains a satisfactory degree of fluidity. This is a necessary factor because of the heat which is generated in press rooms in summer, and the heat produced by friction in the press itself. This ink vaporizes completely between 150 and 300F. Above 300F, the paper becomes brittle and threatens to discolor.

Another problem in developing the heating device was a way of bringing the temperature of the web of paper to the point where the solvents in the ink would be disposed through vaporization, and then to reduce the paper temperature to normal.

Synchronize Heat Volume With Press Speed

The heating unit is called upon to heat the paper to within a few degrees of the point where the paper would burn or scorch. The unit has to control the heat to synchronize it with speed changes of the moving paper, and to prevent injury to the web of paper when the press stops. The heating unit's shape and size had to fit into the press without interfering with its functioning.

As installed on the company's No. 1 offset press, the heater consists of a gas-fired unit which applies heat from a gas flame to the web of the paper and concentrates intense heat on a short length of paper as it travels at high speed.

The heating unit is encased in a metal housing and is mounted on a channel iron framework in about the center of the offset press and about 7 ft above the press room floor. Operation of flame control levers by the press room attendant is thus made convenient.

Two complete dryers are mounted on the same support, facing each other, to heat both sides of the paper as the paper passes through the press and moves between dual drying units. While the paper rolls through at 380 fpm, it receives direct radiation from 1200 to 1400F heat which produces almost instant drying of the ink.

Ribbon Burners Heat Paper Web

Each dryer has a ribbon burner consisting of an elongated manifold through which gas is forced. The flame points toward the moving web of paper. Ceramic material is used for the gas ports to prevent transmission of heat from the gas flame back to the burner.

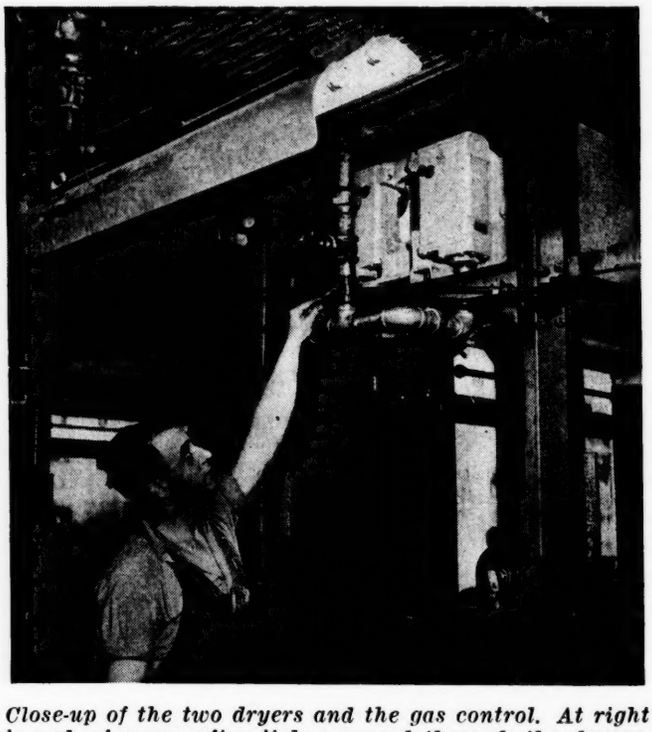
Gas has proven practical in the operation of this heater system because its flame can be controlled. This is important for the rate of gas flow to the burners must be regulated closely to conform with paper web speed. At a constant travel no difficulty has been encountered by the pressmen, but it has been found that if the press is slowed down, or stopped entirely, the paper will scorch or burn unless the heat is reduced almost instantly. Automatic controls are used on the installation to synchronize the heat with the changes of press speed.

Vent System Removes Vapors

A fresh air fan supplies new air through a duct to cool the burners. Solvents freed by heat from the ink are removed by an exhaust fan which draws off the vapors and propels the fumes through a discharge duct to the outside air.

A combustion controller, operating with a 3,500 rpm high-speed turbo blower, forms part of the installation. Premixing the gas with air in proper combustible proportions and feeding it to the burners under pressure is handled by a Selas-designed unit, which assures the required heat concentration necessary for high-speed drying.

The premixer and blower, with auxiliary equipment, are set up on the press room floor convenient to the offset press it serves.



Close-up of the two dryers and the gas control. At right is web of paper after it has passed through the dryers.

Temperature Distribution and Tube Expansion in Radiant Heating Panels

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The accompanying article, the second of a series by the author on various phases of radiant heating, deals with the flow of heat throughout the panel and with the problem of expansion of tubes. Mr. Vanderweil was tempted to omit this latter subject (expansion) from the series on the ground that others may have more extensive data available, but has been persuaded to include his accompanying treatment in the hope that sufficient interest might be aroused and further analytical studies made in the future by those concerned with more correct analytical findings.

The first article of this series appeared in the April issue.

A GREAT number of panel heating systems employ tubes embedded in plaster or concrete. Tubes or pipes not only transport the heating medium — in most cases hot water — to, through, and from the panel, but also play an essential part in the heat transfer within the panel proper. It will be shown that a continuous flow of heat within the panel sets up certain temperature conditions throughout its cross-section which in turn cause expansion of the various materials. The expansion creates compression or tension stresses in the tube, shear stresses in the tube-panel bond, and finally stresses in the panel material or "slab" itself.

Just as the automobile engine was built and operated before its thermodynamic properties were thoroughly explored, radiant heating systems were built and operated satisfactorily throughout the last 40 years in spite of the fact that very little was known about the panel heat flow and even less about the theory of expansion. From experience, it is known to be safe to restrict the (mean) water temperature to 150 or 160F. However, how high this temperature may be raised in various structures without causing expansion cracks or other damage has not been investigated. The reason for the lack of these data is probably found in the fact that the heating engineer does not desire to raise the water temperature to much higher levels, since it is restricted by the low panel surface temperature required for physiological comfort. Nevertheless, the expansion principle should and quite likely will be investigated when, in the future, low conductivity panels are built.

Due to the lack of analytical treatment, this article must be restricted to a general discussion of the expansion problem and should present some of the basic principles rather than an exhaustive study of this problem. When reading the following paragraphs, it should be kept in mind that a great number of radiant heating systems using mean water temperatures of 160F and less have been operating satisfactorily for many years.

Panel Heat-Transfer Properties

In connection with the research program of the Chase Brass & Copper Co., the author had the opportunity to investigate heat flow conditions within the panel and to develop a graphical computation method. Expressed in mathematical terms, this method seems rather complex; however, its physical conception is simple. In the subsequent discussion the actual temperature distribution and the heat flow lines in the panel structure will be discussed in order to base the "expansion problem" on correct data.

In 1937, K. Kalous of Prague (Czechoslovakia) suggested the following theory of panel heat flow:

Referring to Fig. 1, he assumed that heat (q_1) flows horizontally from the tube, through the panel layer p and from here on vertically out to the room (q_3) and through the construction C to the opposite room (q_4). The equations based on these assumptions were checked with a great number of tests taken on panels of various structures, various tube spacing and tube diameters as well as of varying insulation, and were found to be in agreement with only a few of the test readings. The reason for the disagreement may be found in the fact that heat, just as water or electricity, flows along the path of least resistance and cannot be expected to advance first through the layer p and then to "take a right and left turn" to flow into both rooms.

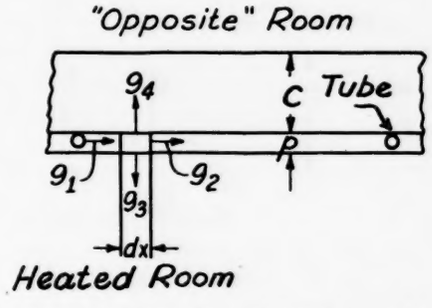

Fig. 1. Heat flow through panels as assumed by Kalous which did not agree with test data.

No better agreement between equations and tests could be achieved when the computations were based on other relatively simple flow con-

ceptions, as radial flow from the tube outward and so on; consequently, it seemed unavoidable to the writer to work out a panel theory based on the natural laws of heat flow. When deriving the new equations, only two simplifying assumptions had to be made. One was

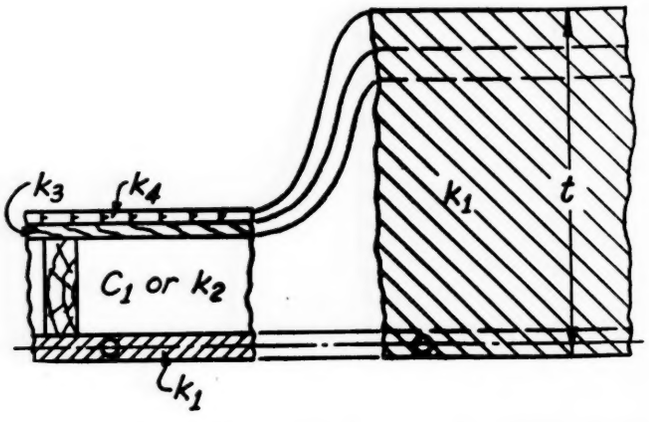

Fig. 2. Comparison of an actual panel (left) with an "equivalent" panel (right) of one material with constant conductivity and computed thickness "t".

concerned with the panel's boundary layers, the other stated that all individual layers of material met in composite panels (such as a pipe coil embedded in plaster and attached to a frame structure) may be replaced by one single layer of constant conductivity and of a definite computed thickness *t*. Fig. 2 shows one actual panel structure in combination with the hypothetical "equivalent panel" of uniform conductivity and thickness *t*. This assumption introduced certain errors into the equations, but simplified the problem sufficiently so that graphical computation charts could be developed. These charts were rectified according to test readings on actual panels, so as to eliminate all errors introduced by the theoretical assumptions.

Let us now follow the heat flow in a concrete panel or in the equivalent panel of Fig. 2.

The panel is fully heated; that is, all heat supplied through the tubes in the panel is dissipated by the two panel surfaces. Referring to Fig. 3, the tubes are embedded near the ceiling surface and *a* represents the depth of bury and *d* the distance between the tube center lines. The temperatures measured throughout the panel cross-section were plotted and all points of same temperature were connected by full lines (isotherms) labeled 130, 125, etc., down to 85F to designate the temperatures. The isotherm t=130F represents the temperature of the parts of the panel structure that are in direct contact with the tube metal, and also the water temperature. Although a small drop of temperature exists between the water and the 130 isotherm, this drop is so minute that it may be neglected.

Heat flow and electric flow conform to the same laws. Wherever electricity flows through a section of large resistance a measurable voltage drop occurs. However, the voltage drop is of little magnitude when carrying electricity through a small resistance. In the heating panel, the entire flow resistance from tube to room is so large that the small temperature drop caused by the resistance of water-film and tube may be neglected.

Once the lines of equal temperatures or isotherms are located, the heat flow lines may be plotted readily. *At any point throughout the temperature field shown in Fig. 3, the heat flow line is perpendicular to the isotherm.* This again is well illustrated by analogy: The panel flow conditions indicated in Fig. 3 are quite similar to those met with water flowing downhill. If plotted on a contour map, the flow of water at all points is perpendicular to the contour lines and the water flows faster along the steeper slopes which, in a contour map, are indicated by crowded contours. Similarly, then, in Fig. 3, heat flows at right angles to the isotherms and at a faster rate when the isotherms are crowded.

Discussing Fig. 3 another phenomenon may be observed. Some of the heat flow lines are directed upwards at their origin (at the upper half of the tube) but are later deflected and indicate a heat flow downward, toward the room below. An explanation of this phenomenon may be found in the low flow resistance of the thin panel layer *a* between tube and room below, causing some of the heat to take the path of least resistance. If, however, the temperature in the room *above* the panel should be decreased, some heat would no longer be diverted downwards, but would flow upward. Here again the contour map analogy applies. Assume water is supplied to the ridge of a hill to such a degree, that for the given slope conditions on the hill sides, the hill crest proper is continuously covered by one inch of water. The water is carried away partly on the North slope

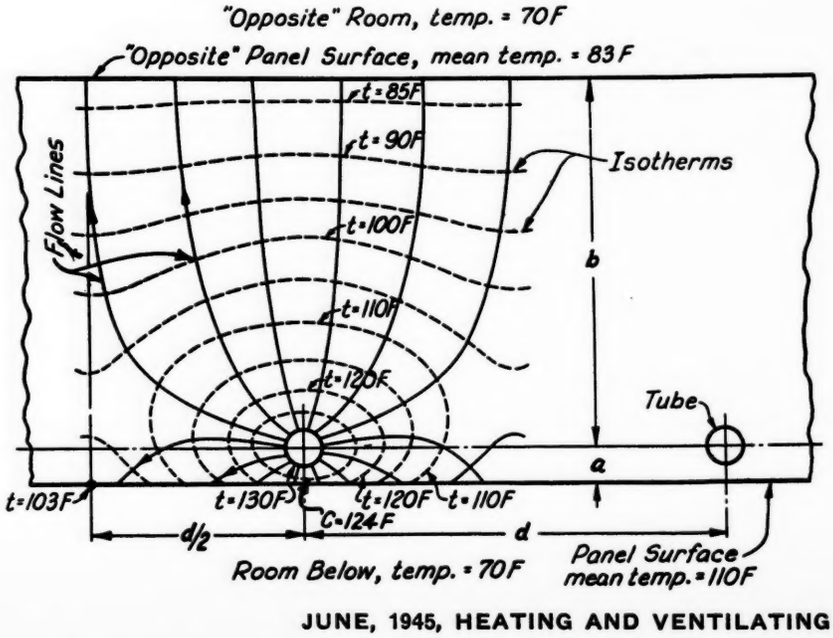

Fig. 3. How heat flows from the tube through the panel. The Isotherms may be located by test readings. Heat flows in paths at right angles to these Isotherms, according to the theory as indicated by the full lines leaving the tube radially.

and partly on the South slope of the hill. Assume next, that the slope of the North side of the hill is increased; then, more water flows into the North direction, the water level on the ridge proper drops (e.g., to 7/8 of an inch) and consequently the flow of

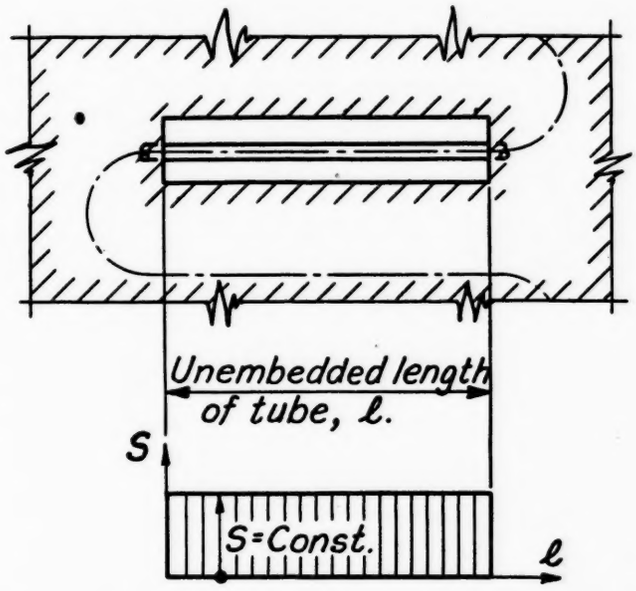

Fig. 4. The stress S in a coil embedded only at the ends (above) is constant through the free length of the tube, as plotted below.

the hill's South slope decreases slightly. Similarly, if the isotherms are more crowded in the upper portion of the panel (due to a greater temperature drop caused by a lower temperature of the room above), but without changing the "slope" below, more heat would flow upward.

From this we conclude that *the heat output into the lower room is affected by the "opposite" insulation of the panel, as well as by the temperature of the opposite room,* and the same tube arrangement will deliver more or less heat into the room depending upon the conditions at the opposite panel side.

Outline of Theory and Expansion Stresses

A short review of the expansion problem in general seems desirable. The free linear expansion of a rod or tube increases with its temperature change, its length, and the coefficient of expansion. This is stated by the following equation:

$$d = t_d L k_e \quad \ldots\ldots (1)$$

when d = change of length,
t_d = difference in temperature,
L = length of tube, and
k_e = coefficient of expansion for material in question.

The average coefficients of linear expansion k_e for some of the materials involved are:

Steel	.0000062
Wrought iron	.0000067
Concrete	.0000070
Copper	.0000093
Plaster	.0000094

all expressing expansion in feet per foot of length per F temperature rise. Thus, if a steel rod of L = 10 ft at 50F is heated to 200F the resulting change of length is, according to equation (1): d = (200 — 50) 10 × .0000062 = .0093 ft. or 0.115 in. and the total final length of the heated rod is 10.0093 ft.

Consider a case where the steel rod cannot expand freely but is rigidly supported at both ends. It is well known that materials such as steel are compressible. If the steel is now heated from 50 to 200F the supports must exert a force great enough to compress the rod of a free length of 10.0093 ft to its original dimension—that is, to 10 ft. The law governing the deformation of elastic materials may be stated as:

The force required to deform (compress) a material is proportional to the degree of deformation (that is, deformation per foot of length) and to the elastic properties of the material. In symbols, and for a cross-section of 1 inch, this is expressed by:

$$S = (d/L)\ E \quad \ldots\ldots (2)$$

where S = force per sq in of cross-section, or unit stress,
d/L = reduction of length per foot of rod, or, more generally, the change of length per unit length (dimensionless), and
E = coefficient defining the elastic properties of the material, or the modulus of elasticity, which is given in pounds per square inch and is approximately:

Wrought iron or steel	28,000,000
Copper	15,000,000

In the foregoing example the reduction in length must equal the computed .0093 ft and the reduction per unit length is: d/L = .0093/10 = .00093 ft per ft. The stress set up in the steel rod is thus: S = .00093 × 28,000,000 = 26,000 lb per sq in. If a copper rod had to be compressed and reduced for the same .0093 ft the stress would amount to: S = .0093 × 15,000,000 = 14,000 lb per sq in. The force required to restrict a rod, of a 2 sq in cross-section, amounts to 52,000 lb for the steel rod and to 28,000 lb in the case of a copper rod.

By combining equations (1) and (2) we obtain:

$$S = (t_d L k_e)/L \times E = t_d k_e E \quad \ldots\ldots (3)$$

It may be seen that by substitution of d the initial length L of the rod is eliminated and that the tube stress caused by the expansion tendency of a "restricted" rod is independent of the tube length, and changes only with the material used, that is, with the constants k_e and E and the change of temperature t_d.

All of this results in several conclusions for a tube supported at both ends:

Free Expanding Tube. A rod or tube not restricted against axial movement expands freely when heated, and the change of length is greater with longer tubes and larger changes of temperature.

Stress. In a rod or tube restricted against longitudinal expansion by rigid support at the ends, stresses are built up which cause tube compression if the tube is heated and tension if it is cooled.

According to equation (3) the magnitude of these stresses is independent of the length of the tube.

Force. The force required to restrict the rod or tube changes with the temperature, the material and with the cross-section, but is independent of the tube length.

Expansion of Embedded Tubes

The previous consideration may be extended to the embedded tube but considerable complications will be met when analytical equations have to be developed. Realizing this, and knowing from previous installations that the expansion of low temperature panels causes little trouble in practice, it was found sufficient to investigate this problem by test rather than by mathematical analysis. In order to receive a rough check on the results experienced in practice, two special cases were considered which individually are of no consequence to the actual panel. This panel represents more or less a combination of both cases.

Case 1. First, a tube coil is assumed as in Fig. 4 with both ends embedded in a panel of a different coefficient of thermal expansion. Disregarding the problem of the embedded bend, it may be assumed with fair approximation that throughout the unembedded length l, a deformation force acts as soon as the tube-panel structure is heated. Assuming an unheated temperature of 70F and conditions for a practical example as shown in Fig. 3, with a tube temperature of 130F and a mean temperature of the panel sections near the tube of 120F, and assuming the most unfavorable case, copper tube embedded in concrete, we have:

Expansion of copper

$$(130 - 70) \times .0000093 = .00056 \text{ ft per ft.}$$

Expansion of concrete

$$(120 - 70) \times .0000070 = .00035 \text{ ft per ft.}$$

Differential expansion copper-concrete ($t_d k_e$) $= .00021$ ft per ft.

According to equation (3) the resulting stress in the copper *tube* is:

$$S = .00021 \times 15{,}000{,}000 = 3150 \text{ lb per sq in.}$$

The lower diagram in Fig. 4 represents the compressive stress which is constant throughout the unembedded tube. The stress computed represents a good average for copper tubes embedded in a concrete slab. In some extreme cases, due to the use of higher water temperatures in ceiling panels, the stresses may increase to 4500 lb per sq in but always remain appreciably lower than the yield point stresses shown in Table 1. For a ½ inch nominal copper tube of .625 O.D. and .0735 sq in cross-section, the compressive force acting at the embedded portion of the previous example is computed by:

$$F = .0735 \times 3150 = 232 \text{ lb}$$

Data on tensile strength, yield strength and shear strength for copper and brass tubing are given in Table 1.

TABLE 1.—TENSILE, YIELD AND SHEAR STRENGTH FOR COPPER AND BRASS TUBING
(Figures are in pounds per square inch)

	Tensile Strength	Yield Strength	Shear Strength
Annealed copper tube	32,000	10,000	23,000
Hard copper tube	50,000	45,000	28,000
Annealed commercial brass tubing	52,000	20,000	•32,000
Hard commercial brass tubing	80,000	62,000	42,000

Although the yield points are slightly lower at 170F than the values in Table 1, the actual loading may be higher in the case of compression as met in the panel, so that the values given in this table may be used.

The tube expansion tendency produces stresses in the *slab* which are distributed throughout the relatively heavy concrete cross-section and are small in all practical cases. For instance, in a concrete panel only 1.5 in. high and with 4½ in. tube spacing, the average tensile strength at the supporting section amounts to approximately:

$$S_c = 232/1.5 \times 4.5 = 34.3 \text{ lb. per sq in}$$

for the example considered. It is true that locally (near the tube) higher stress concentrations must be encountered, but these local stresses cannot exceed the minimum tensile stress of concrete of approximately 350 lb per sq in, unless the tube bury is extremely shallow. This conclusion was verified by experiment as well as by practical installations.

Case 2. The tube center section is embedded in concrete, the ends are free, as shown in Fig. 5. Due to the lack of tests concerned with determination of elastic data, deflections and stresses in the heated panel structure, this case is less amenable to analytical treatment than the one previously discussed. The lower diagram of Fig. 5 approximates the compressive stresses in the tube section (full line) as well as the shear stress in the tube-concrete bond (dashed line). As the arrangement of this figure is symmetrical to the center, no expansion of the tube relative to the concrete is met at this point, and the *bond* stress must equal zero. As we depart from the center sections, the expansion tendency increases and hence the restricting bond stresses which will be greatest at the ends. If the tube is heated to high temperatures, it is feasible to assume that the bond

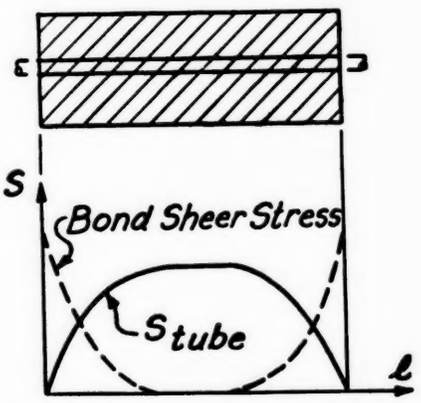

Fig. 5. A tube embedded only throughout its center section (above) is under stresses varying as plotted below.

breaks away progressively, starting from both ends. This is not true for the temperatures used in practice. In order to check this statement, copper tubes of various lengths were set up in tests according to Fig. 5 and intermediately heated to conventional temperatures (200F). No bond breakage and no surface cracks were observed. To determine by experiment the average bond breaking stress, a second test was run, and a number of straight rods were embedded in concrete and forcibly pulled out of the panel. It may well be assumed that the distribution of bond breaking stresses in this test is much like the one shown in the diagram of Fig 5. The average breaking stress of the bond was found to vary from 73 to 93 lb per sq in. These tests were taken on relatively short tubes, because of the high forces required to sever the concrete-copper bond. The bond breaking force proved to vary from 1400 to 1800 lb per foot of ½ in. O.D. smooth copper rod. The variation of force may be explained by the difference in bond quality. No attempt was made to rigidly control the concrete mixture or the joining procedure in order to duplicate practical installation conditions. It may be expected that the bond strength of relatively rough ferrous pipes in concrete is even greater, and whatever the material, it must be greatly in excess of the stresses set up by thermal expansion. The mean expansion stress, if computed according to the highly unfavorable "case 2" and for our example, using a tube of only three feet length, appears to be 10.2 lb per sq in or 14% of the tested breaking shear stress and must be appreciably smaller with the fully embedded tube.

As the *tube* compression in the case presented by Fig. 5 is caused by the bond stresses (no other compressing force is available), it must vary from zero at the edges to a maximum near the center, as indicated. The magnitude of the resulting maximum stress is unknown and so far no analytical treatment has been given to this problem. However, it will be necessary more thoroughly to investigate the expansion problem if in the future the use of high temperature, low conductivity panels is considered.

Actual Panel. When embedding copper tubes into concrete panels and using conventional water temperatures, the following conclusions may be drawn. Due to the fact that both the bends and the center section of the coil are buried, compression is applied at the end of the tubes and the stress throughout the straight run of the *tube* remains nearly constant and approximately of a magnitude as computed in Case 1. It is quite likely higher at the center and in the bends, but will not exceed the ultimate stress of 10,000 lb per sq in which would be required to cause plastic deformation in annealed copper tubing.

The stresses built up in the *panel* proper, due to its tendency to restrict the tube expansion, are of little consequence wherever the panel cross-section is large enough. By "small cross-sections" are meant those with relatively thin concrete layers with a small tube cover and where very small tube spacings are used. Generally, tube spacings smaller than 4 in. should not be used without increasing the tube cover. With conventional layouts, the expansion stress in the relatively heavy concrete cross-section is of small magnitude and, with the temperatures used, expansion cracks will not occur unless the tube cover is inadequate.

Shear stresses in the *concrete-tube bond* proved to be too small to break this bond in the tests using free end tubes (see Fig. 5) and can be of no consequence in the actual panel where the tube ends are embedded.

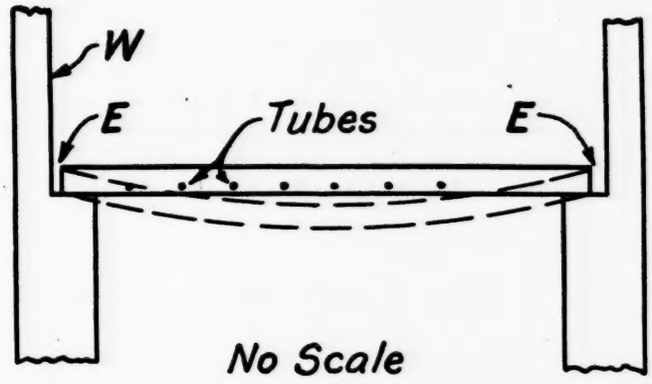

Fig. 6. Expansion space E should be provided for in the panel in both directions (North-South and East-West).

Similar conditions are met when embedding ferrous pipes in plaster. Due to the smaller expansion tendency of the pipe when heated, it will be in a state of tension rather than compression. Also, due to the greater difference between the coefficients of expansion and due to the greater modulus of elasticity, the stresses in the *pipe section* will be numerically greater than those met in copper-concrete installations, but by no means critical because of the much higher tensile strength of ferrous metals. The stresses in the *panel* may become critical if a thin layer of plaster should be applied. However, it was proved by many European ceiling installations that no expansion cracks will occur if a relatively heavy plaster (greater than 1-in. for ½-in. pipes) is used. The *bond* shear stresses again are of no consequence.

When embedding ferrous pipe in concrete or copper in plaster, the difference between the coefficients of expansion is so small that all stresses created in tube, bond and panel are of minor importance.

Superimposed upon the stresses in the slab caused by tube reaction are those stresses created in the slab proper by (1) restriction of slab expansion and (2) difference of temperature at various points of the slab. The expansion stresses of concrete slabs may be of great magnitude wherever the panel is restricted in its free expansion. Expansion joints (refer to Fig. 6) allowing expansion of the panel in two directions (North-South and East-West) should be provided in all cases where the forces that would be caused by restricted expansion cannot be properly dissipated by strong restricting structures; that is, by the wall *W* of Fig. 6.

The change in temperatures in the panel as shown in Fig. 3 will alter the reacting forces in the case of restricted expansion and cause bending of the

slab of free expanding panels as indicated by the dashed lines in Fig. 6. According to Fig. 3 the average temperature at the tube level is higher than at any other panel elevation and greater expansion will take place at the surface near the tube than at the opposite slab surface. The bending radius of the surface is extremely large and of no importance, as may be readily approximated by using the coefficient of expansion for concrete in combination with mean panel temperatures as given in Fig. 3. The difference in temperature at various points of the panel cross-section may cause minor stresses within the panel even in "free expanding" installations.

Recapitulating, it may be stated that in free expanding slabs, no considerable stresses other than those produced by the tubes are met. Where no provisions are made for free expansion of the panel and particularly with concrete panels of large cross-section, great forces may occur calling for heavy structures supporting the panel circumference. In general, free expansion should be provided for at the periphery of the panel. Where concrete panels of large dimensions, calling for intermediate slab expansion joints, are planned—as in industrial layouts, airport runways, and so forth, and heated by tubes, flexible tube connections should be arranged at each concrete joint. The tube connections should not be restricted in their motion and should be of sufficient flexibility to compensate for expansion of the interconnected tube coils.

Conclusions

The problem of expansion is of great theoretical interest and will prove of practical interest as soon as low conductivity panels employing high water temperatures are used commercially. Little design consideration has to be given to the expansion problem with the presently used panels.

As was shown, none of the stresses within panel and tube proved critical if free expansion of the slab is secured and if an appropriate panel cross-section and tube cover are provided. Sufficient tube cover is most important for ferrous tubes in plaster panels and for copper tubes in concrete slabs. Copper in plaster and steel or wrought iron in concrete prove to be safe with relatively small depths of cover.

When laying out coils for radiant heating systems, not only the expansion problem but a number of other important factors, such as venting, bending and joining tubes should be considered. These problems will be discussed in a subsequent article.

Design of "Open-and-Shut" Type Hoods

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In the design or construction of branch ducts having hoods which are of the "open-and-shut" type, such as are used on melt ovens, and mixing or reactor kettles, conditions arise which will throw the system "out of kilter" unless provided for in the design. For instance, with the usual duct design in a branch to a hood over a melt kettle one or more of the following conditions will arise:

1. If the hood over the melter is fairly tight fitting, little, if any, air will enter the hood except when the doors or lids are open for inspection or charging. The fume and dust concentration in the exhausted air will be at a peak when the hood is closed and transporting velocity will be almost nil.

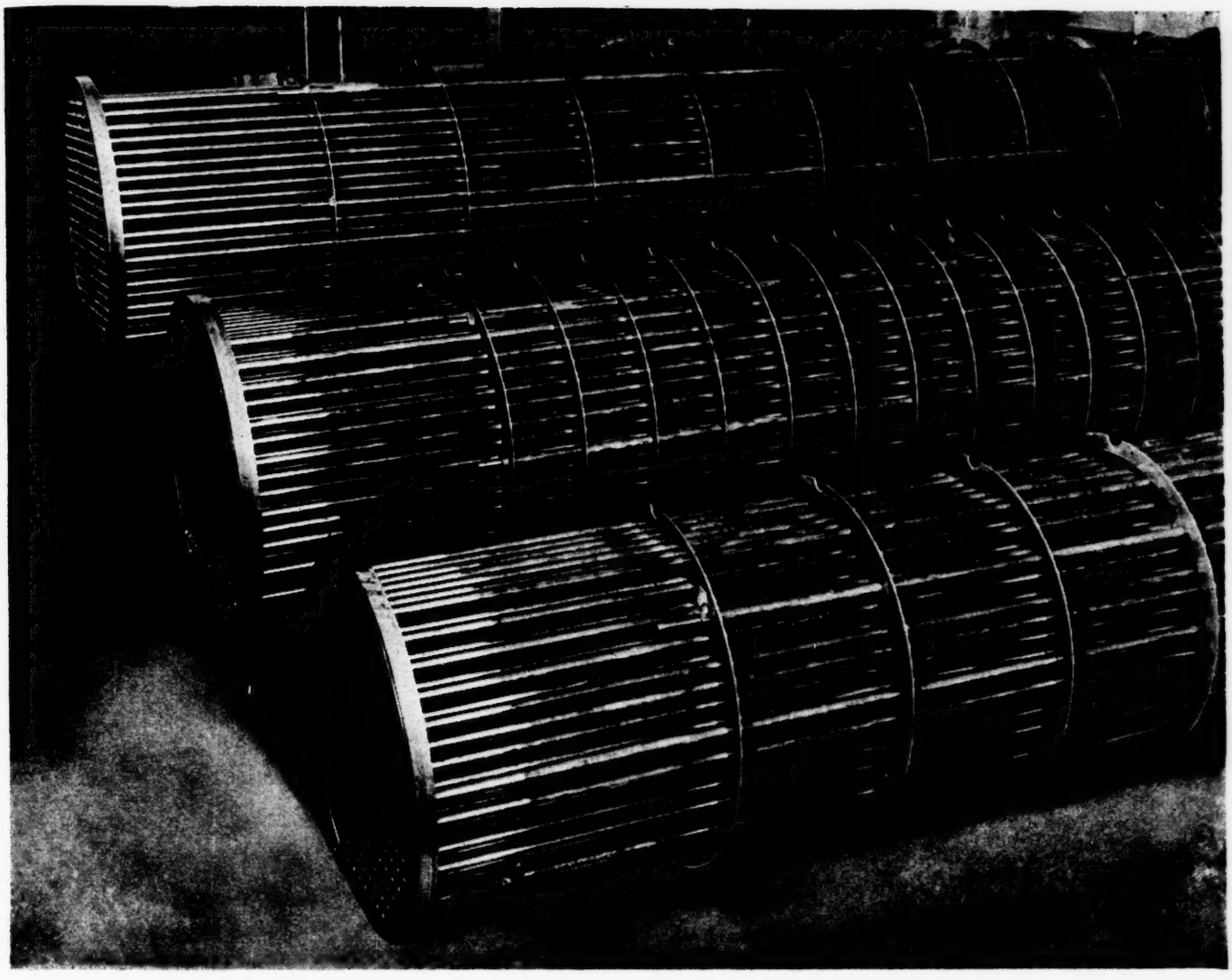
2. If a collector is located close to the hood to remove the contaminant, it will not operate effectively, if of the cyclone or wet-washer type, when the lids or doors to the hood are closed.

3. If the branch to the hood over the melter is the only source of mechanical ventilation to this room or bay, it will be cut off most of the time and a health hazard may arise from excessive atmospheric contamination caused by minor scattered sources which would be diluted to a safe level if the local exhaust were operating all the time.

4. If the hoods are loose fitting a higher local exhaust rate is required to control the contaminant properly and the air entering the hood is heated thereby increasing unnecessarily the heat loss from the melter.

The problems created by the foregoing conditions can be solved by using a streamlined Y to connect the hood with the branch, and by installing a barometric damper in the open leg of the Y. With this arrangement most, or all, of the air will enter through the lids or doors of the hood when open and though the damper when the hood doors are closed. Thus the transporting velocity in the ducts will be maintained, the general ventilation of the room provided by the local exhaust branch will be in effect at all times, and any collectors which may be located in the branch will operate satisfactorily.

It is therefore very important that an alternate and automatically operating opening or hood be provided close to the primary hood in all branches which are connected to hoods of the "open-and-shut" type. For this purpose, barometric dampers, or dampers actuated by the doors or lids on the primary hood, located in a branch-to-room opening are recommended.



Tube bundles for three heat exchangers such as are used in food processing plants.

Welded Stainless Steel Tubing

INDUSTRIAL pipe lines carrying active chemical solutions and vapors must be resistant to the corrosion caused by these materials and it has been found that electric welded stainless steel tubing provides this resistance. Such tubing is made by passing flat-rolled steel through a series of forming rolls which form it into a cylinder and press the edges into contact. Then heavy current flows through the metal, welding the seam and forming a solid wall without the addition of any extraneous metal. The result is tubing with all the inherent advantages of flat-rolled stainless steel plus a weld as strong and corrosion-resistant as the rest of the wall. Commercial lengths are 25 feet or less, but longer tubes are available for special applications.

Unlike regular pipe, steel tubing is not threaded for joining one length to another. Special means are used such as attaching fittings by soldering or welding. For this reason the tubing need be no thicker than the thickness required for the mechanical strength involved.

While welded stainless steel tubing costs 8 to 10 times as much as carbon steel pipe of the same size and gauge, tubing of a much lighter gauge is appropriate and replacements are far less frequent than when ordinary pipe is used.

The chromium-nickel group (approximately 18% chromium and 8% nickel) is the most commonly used and variations of the basic 18-8 analysis have been produced by the addition of supplementary alloying elements to develop specific properties such as higher corrosion-resistance, stability at high temperatures, resistance to scaling, etc.

To meet the requirements of welded construction where it is important that the material next to the joint be as highly corrosion-resistant as the other parts of the line, 18-8-S (Type 304) was developed. It is satisfactory for temperatures up to about 1600F,

TABLE 1.—PROPERTIES OF STAINLESS AND HEAT-RESISTING STEELS

ENDURO TYPE NUMBER	*18-8	18-8-STi	18-8-SCb	18-8-SMo	HCN
American Iron and Steel Institute Type Number	302	321	347	316	309
APPROXIMATE CHEMICAL COMPOSITION	C Over .08-.20% Mn 1.25% Max. Si .75% Max. S and P .03% Max. Cr 17.5-20.0% Ni 8-10%	C .10% Max. Mn 1.50% Max. Si .75% Max. S and P .03% Max. Cr 17-20% Ni 7-10% Ti Min. 4 times C	C .10% Max. Mn 2% Max. Si .75% Max. S and P .03% Max. Cr 17-20% Ni 8-12% Cb Min. 10 times C	C .10% Max. Mn 1.50% Max. Si .75% Max. S and P .03% Max. Cr 16-18% Ni 10-14% Mo 2-3%	C .20% Max. Mn 1.50% Max. Si 2% Max. S and P .03% Max. Cr 22-26% Ni 12-14%
PHYSICAL PROPERTIES					
Density					
gm/cm³	7.93	7.98	7.98	7.98	7.98
lb/in³	.286	.288	.288	.288	.284
Modulus of Elasticity, 10^6 lb/sq in.	29	29	29	28.5	30
Specific Heat, Btu/F/lb 0-200F	.118	.118	.118	.118	.118
Specific Heat, Cal/°C/gm 0-100C	.118	.118	.118	.118	.118
Thermal Conductivity, Btu/sq ft/hr/F/in					
200F	110	110	110	108	92.5
1000F	150	150	150	147	113
Linear Coefficient of Thermal Expansion, per °F × 10^{-6}					
0-200F	9.0	8.8	8.8	8.4	8.0
0-600F	9.5	9.2	9.4	9.0	8.6
0-1000F	10.1	10.2	10.2	9.7	9.5
0-1500F	11.1	11.3	11.3	11.0	10.8
Melting Point	2550-2600F	2550-2600F	2550-2600F	2500-2550F	2500-2550F
NOMINAL VALUES OF MECHANICAL PROPERTIES					
Hardness					
Brinell number, Annealed	135-185	135-185	135-185	135-185	140-185
Brinell number, Heat-Treated	.....	.....	.....	.....	.....
Brinell number, Cold Rolled	180-330	180-300	.....	180-300	.....
Rockwell number, Annealed	75-90B	70-90B	70-90B	70-90B	78-90B
Rockwell number, Heat-Treated	.....	.....	.....	.....	.....
Rockwell number, Cold Rolled	10-35C	10-35C	.....	10-30C	.....
Ultimate Tensile Strength,					
lbs/sq in, Annealed	80,000-90,000	80,000-90,000	80,000-90,000	80,000-90,000	90,000-110,000
lbs/sq in, Heat-Treated	.....	.....	.....	.....	.....
lbs/sq in, Cold Rolled	100,000-180,000	100,000-180,000	.....	100,000-150,000	.....
Yield Point,					
lbs/sq in, Annealed	35,000-45,000	35,000-45,000	35,000-45,000	35,000-55,000	40,000-60,000
lbs/sq in, Heat-Treated	.....	.....	.....	.....	.....
lbs/sq in, Cold Rolled	50,000-150,000	50,000-150,000	.....	50,000-125,000	.....
Elongation in 2 in, Annealed	60-55%	60-55%	60-55%	70-60%	65-50%
Elongation in 2 in, Heat-Treated	.....	.....	.....	.....	.....
Elongation in 2 in, Cold Rolled	50-10%	50-10%	.....	50-15%	.....
Reduction of Area, Annealed	65-55%	65-55%	65-55%	75-60%	65-50%
Reduction of Area, Heat-Treated	.....	.....	.....	.....	.....
Impact Strength					
Izod value, ft lbs, Annealed	110-70	.....	.....	120-70	.....
Izod value, ft lbs, Heat-Treated	.....	.....	.....	.....	.....
Ductility					
Olsen, inches, Annealed	.500-.400	.....	.....	.....	.....
Ericksen, millimeters, Annealed	14-11	.....	.....	.....	.....
Creep Strength for a life of 10,000 hours with 1% elongation					
At 1000F, lb/sq in	17,000	18,000	.....	25,000	17,000
At 1100F, lb/sq in	12,000	13,000	.....	20,000	13,000
At 1300F, lb/sq in	4,000	4,500	.....	10,000	4,800
At 1500F, lb/sq in	850	850	.....	3,000	850
Strength at Elevated Temperatures					
Short time tests 1300F	42,000	56,000	56,000	60,000	54,000
1500F	28,000	32,000	32,000	40,000	32,000
1700F	18,000	18,000	18,000	18,000	16,000
HEAT-TREATMENT					
Annealing	Quench from 1850F-1950F	Quench from 1850F-2000F	Quench from 1950F-2050F	Quench from 1950F-2050F	Quench from 2000F-2100F
Hardening	Non-hardening	Non-hardening	Non-hardening	Non-hardening	Non-hardening
Tempering	Non-hardening	Non-hardening	Non-hardening	Non-hardening	Non-hardening
Forging	Start at 2100F, Finish over 1700F	Start at 2100F, Finish over 1700F	Start at 2250F, Finish over 1800F	Start at 2200F, Finish over 1700F	Start at 2150F, Finish over 1800F
HEAT-RESISTANCE					
Scaling Temperature					
Continuous service	1600F	1600F	1600F	1650F	2000F
Intermittent service	1450F	1450F	1450F	1500F	1800F
WELDING PROPERTIES	Very good—tough welds	Very good	Very good	Very good	Good
MACHINING PROPERTIES	Fair—tough	Fair—tough	Fair—tough	Fair—tough	Fair—tough
DRAWING OR STAMPING	Very good	Good	Good	Good	Good

*These data apply also to modifications of this analysis: Enduro 18-8-S and 20-10-S, with .08% max. carbon.

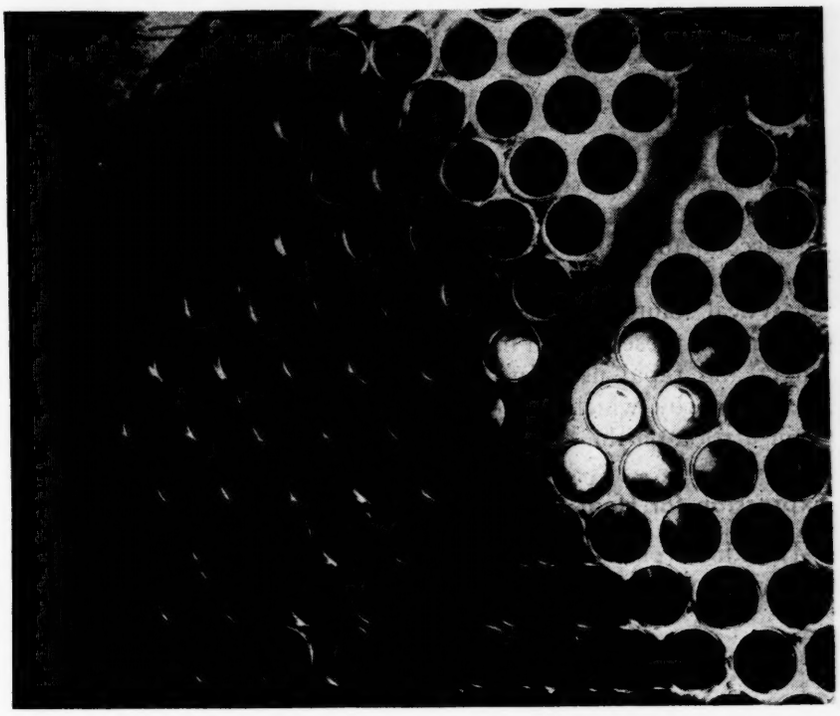
but if in continuous service within the temperature range of 1000F to 1500F, the stabilized types, 18-8-STi (Type 321) or 18-8-SCb (Type 317), should be used. The stabilized types are recommended in this range because carbides will develop and intergranular attach may occur in the straight 18-8-S type.

For use in acid corrosive conditions such as the manufacture of sulfite pulp and paper production where dilute sulfurous acid and calcium bisulfite are the active cooking agents, 18-8-SMo (Types 316 and 317), which contains 2 to 3% molybdenum, is recommended, for it is resistant to phosphoric, acetic and in some cases to sulfuric and hydrochloric acids. It is much more resistant to pitting than the other chromium-nickel alloys and is used largely in the pharmaceutical and drug industries where absolute freedom from contamination is necessary.

To increase the resistance to scaling and oxidation at high temperatures 18-8-B (Type 302B), which contains 2 to 3% silicon, is used. It is satisfactory for temperatures up to about 1600F. A thin, tight scale is formed which does not flake off so this alloy is used for furnace parts and retorts.

HCN (Type 309), which contains 25% chromium and 12% nickel, is resistant to corrosion and in addition is highly resistant to oxidation at temperatures as high as 1950F.

Data and photographs supplied through the courtesy of Republic Steel Corporation, Steel and Tubes Division.



Part of a stainless steel heat exchanger constructed for a pharmaceutical plant. Tubes are No. 16 gauge, 2½ in. outside diameter. The ⅝ in. thick tube sheet is 6 ft in diameter.

TABLE 2.—CORROSION RESISTANCE OF STAINLESS STEEL TO VARIOUS CHEMICAL MEDIA

Substance	Condition	Temp. F	18-8 SMo	18-8
Acetic Acid				
60%		100	I	I
60%		180	I	I
60%		Boiling	II	III
Acetone		70	I	I
Alcohol, Ethyl		70	I	I
Alcohol, Methyl		70	I	I
Aluminum Hydroxide	Saturated	70	I	I
Aluminum Sulphate				
5%		150	I	*I
10%		70	I	*I
10%		Boiling	I	*II
Saturated		70	I	*I
Saturated		Boiling	I	*II
Ammonium Chloride				
10%		Boiling	*I	*I
20%		Boiling	*I	*I
50%		Boiling	*I	*II
Ammonium Sulphate				
5%	Agitated	70	I	I
10%		Boiling	*I	*II
Beer				
Barley, Malt and Hops		70	I	I
3.5%-4.5% Alcohol		160	I	I
Benzene (Benzol)		70	I	I
		Hot	I	I
Blood (Meat Juices)		Cold	I	*I
Calcium Chloride				
Dilute		70	*I	*II
Conc. Solutions		70	*I	*II
Calcium Hydroxide				
20%		Boiling	I	I
50%		Boiling	II	III
Carbonated Water (Carbonic Acid)			I	I
Carbon Tetrachloride				
C.P.		70	I	I
C.P.		Boiling	I	I
Commercial Plus 1% Water		Boiling	*II	—
Commercial Plus 1% HCL		Boiling	*II	—
Chlorine Gas				
Dry		70	I	I
Moist		70	III	IV
Hydrogen Sulphide				
Dry		70	I	I
Wet		70	†I	†III
Muriatic Acid		70	V	V
Nickel Sulphate		Cold and Hot	I	I
Nitric Acid				
50%		70	I	I
50%		Boiling	I	I
Fuming Conc.		70	I	I
Fuming Conc.		110	I	I
Fuming Conc.		Boiling	IV	IV
Photographic Solutions				
Film and Paper Developers		70	I	I
Hypo (Acid Fixing Baths)		70	†I	†I
Sodium Chloride				
20%	Aerated	70	I	*I
Saturated		70	I	*I
Saturated		Boiling	I	*II
Sulphuric Acid				
5%		70	II	III
5%		Boiling	III	V
10%		70	II	III
10%		Boiling	IV	V
Conc.		70	I	I

In table approximate corrosion resistance is indicated as follows: I fully resistant; II satisfactorily resistant; III fairly resistant; IV slightly resistant; V not resistant.

*Subject to pitting at air line or when allowed to dry.

†May attack when sulphuric acid is present.

Heat Losses from Insulated Air Ducts

CHARLES H. KILPATRICK*

THE need for a simple method of evaluating heat losses from air ducts prompted construction of the accompanying graph. The purpose of this chart is to combine and simplify the equations needed for an analytical solution of duct heat loss (or gain) problem and to present them in a form which will permit direct and rapid use. Included in the presentation are means by which the effect of various amounts of insulation on the heat loss can be considered.

Expression for Heat Loss

Heat loss (or gain) for a given length of duct can be expressed by the equation,

$$Q = UPL\left[\frac{t_1 + t_2}{2} - t_3\right] \quad \ldots\ldots\ldots\ldots (1)$$

where Q is the rate of heat loss (or gain), Btu per hour; U is the overall coefficient of heat transfer, Btu per square foot per hour per F; P and L are, respectively, the perimeter and length of the duct in feet; t_1, t_2 and t_3 are, respectively, the air temperature entering the duct, temperature leaving the duct, and temperature of the air surrounding the duct. A graphical solution of equation 1 is given by the nomogram which appears at the top of the graph.

The overall coefficient of heat transfer is given by the equation,

$$U = \frac{1}{\frac{1}{f_i} + \frac{L}{K} + \frac{1}{f_o}} \quad \ldots\ldots\ldots\ldots (2)$$

in which f_i and f_o are the inside and outside film coefficients, and $\frac{L}{K}$ is the thermal resistance of the insulation. The inside film conductance varies with air velocity and duct diameter, while the L/K term varies with the thickness and thermal conductivity of the insulation. Then to calculate heat loss, a means is needed of first evaluating the overall coefficient for the particular system. The inside film coefficient can be approximated by Schultz's modified equation,

$$f_i = \frac{0.32\ (V_s)^{.8}}{D^{.25}} \quad \ldots\ldots\ldots\ldots (3)$$

where V_s is the air velocity in feet per second, and D is the duct diameter in feet. An average fixed outside film conductance, f_o, of 1.65 Btu per hour per square foot per F has been assumed.

To account for the insulation, a novel method of plotting was devised, wherein a series of intermediate connecting curves are used to evaluate the L/K term and to establish the value of U as given in equation 2. These curves are shown at the lower right of the graph.

A further problem was to graphically determine the temperature of air leaving the duct. This temperature can be expressed by the equation,

$$t_2 = \frac{t_1\,(y - 1) + 2t_3}{y + 1} \quad \ldots\ldots\ldots\ldots (4)$$

$$\text{where: } y = \frac{7.2\ DVP}{UL} \quad \ldots\ldots\ldots\ldots (5)$$

in which D is the duct diameter in feet, V is the air velocity in feet per *minute*, P is the density of the air at temperature at which V is measured, and L is length of duct in feet. Having solved for U, and knowing D, V, P, and L, t_2 can be evaluated.

Equation Simplified

To simplify the graphical construction, L has been taken as 100 feet, the final heat loss being expressed in Btu per hour per 100 feet. The error made in using this value to obtain heat losses for other duct lengths will usually be very slight and not of practical importance. Another modification is that results are given in terms of $(t_2 - t_1)$, the temperature rise or drop in 100 feet. From equation 4,

$$t_2 - t_1 = \frac{2t_3 - t_2 - t_1}{y} \quad \ldots\ldots\ldots\ldots (6)$$

Since $(t_2 - t_1)$ is usually less than 4F, and since $2t_3$ is normally around 130F, the right side of equation 6 can be simplified—with a loss of not over 3% accuracy—by reducing this equation to the form,

$$t_2 - t_1 = \frac{2(t_3 - t_1)}{y}$$

While this graph has been constructed for circular ducts, it can readily be extended to rectangular ducts by noting that,

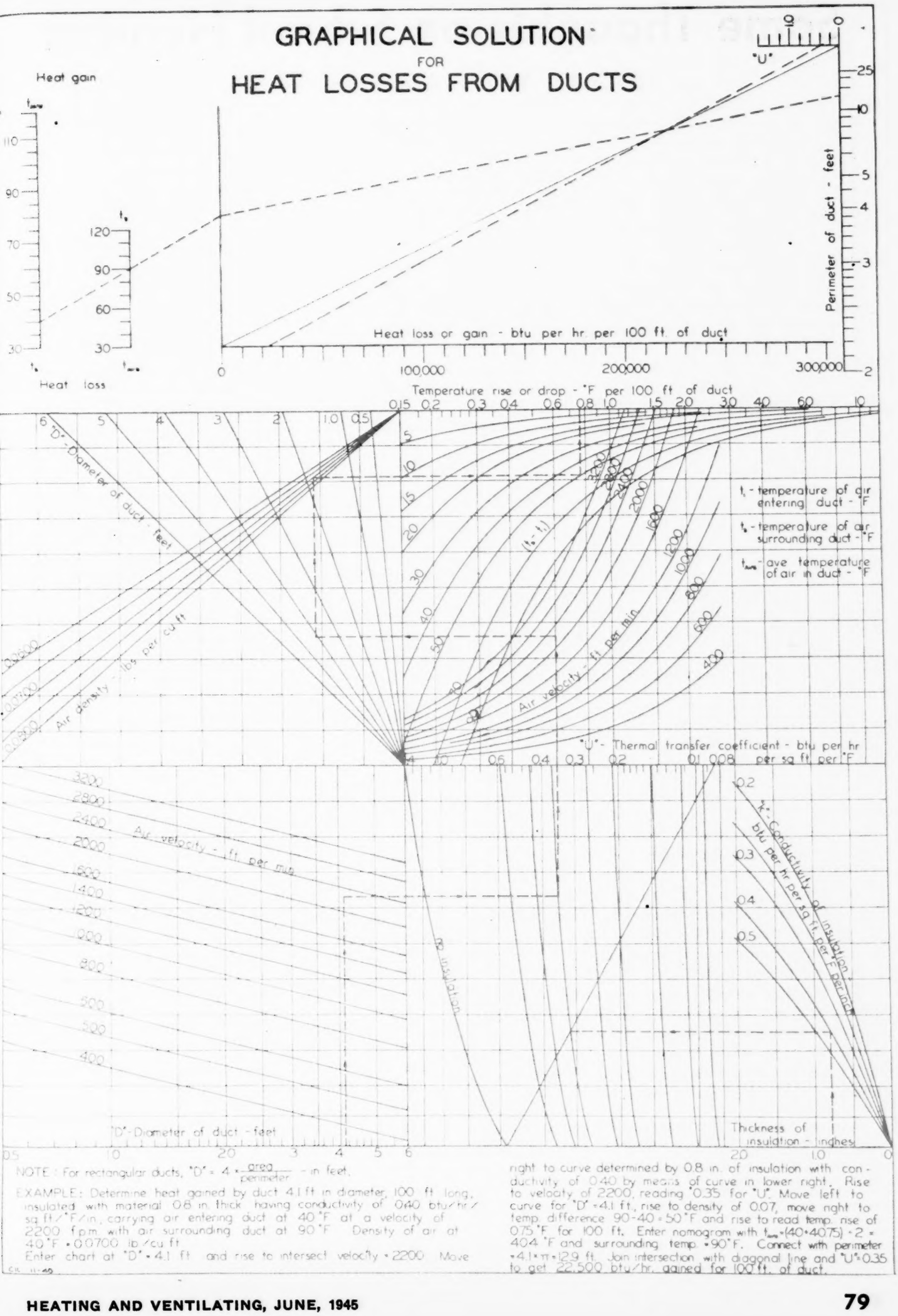
$$r_h = \frac{A}{P} = \frac{D}{4} \quad \ldots\ldots\ldots\ldots (7)$$

where r_h is the hydraulic radius, A the cross-sectional area of the duct, and P the wetted perimeter. By substituting $4 \times \frac{A}{P}$ for D, the solution may be used for rectangular or square ducts.

The graph can also be used in the reverse direction, solving for the required thicknesses of insulation to give an allowable heat loss or gain.

*Ensign, USNR, deceased. See biography in "Getting Personal" Department.

GRAPHICAL SOLUTION FOR HEAT LOSSES FROM DUCTS


Heat gain
Heat loss
Heat loss or gain - btu per hr per 100 ft of duct
Perimeter of duct - feet
"U"
Temperature rise or drop - °F per 100 ft of duct
"D" - Diameter of duct - feet
Air density - lbs per cu ft
Air velocity - ft per min
t_i - temperature of air entering duct - °F
t_s - temperature of air surrounding duct - °F
t_{av} - ave temperature of air in duct - °F
"U" - Thermal transfer coefficient - btu per hr per sq ft per °F
k - Conductivity of insulation - btu per hr per sq ft per F per inch
Thickness of insulation - inches
"D" - Diameter of duct - feet

NOTE: For rectangular ducts, "D" = $4 \times \frac{\text{area}}{\text{perimeter}}$ - in feet.

EXAMPLE: Determine heat gained by duct 4.1 ft in diameter, 100 ft long, insulated with material 0.8 in. thick having conductivity of 0.40 btu/hr/sq ft/°F/in., carrying air entering duct at 40 °F at a velocity of 2200 f.p.m. with air surrounding duct at 90 °F. Density of air at 40 °F = 0.0700 lb/cu ft.

Enter chart at "D" = 4.1 ft. and rise to intersect velocity = 2200. Move right to curve determined by 0.8 in. of insulation with conductivity of 0.40 by means of curve in lower right. Rise to velocity of 2200, reading "U" 0.35. Move left to curve for "D" = 4.1 ft., rise to density of 0.07, move right to temp. difference 90 - 40 = 50 °F and rise to read temp. rise of 0.75 °F for 100 ft. Enter nomogram with t_{av} = (40 + 4075) ÷ 2 = 404 °F and surrounding temp. = 90 °F. Connect with perimeter = 4.1 × π = 12.9 ft. Join intersection with diagonal line and "U" = 0.35 to get 22,500 btu/hr. gained for 100 ft. of duct.

Some Thoughts on School Heating

EVEN though building material restrictions have curtailed school building construction and improvements, there has been no halt to the advances being made in the fields of heating and ventilating.

When school construction is again resumed, then instead of continuing where it left off, it will embody some of the newer approaches to the problem.

For that reason, a number of engineers interested in the field were asked the following questions:

1. What are some of the new features that you believe should be made to the building systems of existing but old school buildings?

2. What are some of the new features that you believe should be included in the design of a heating system for a school building?

The views of engineers interested in school problems provide some indication of present day thought.

S. L. Buxbaum, Brooklyn, N. Y.: Hand firing of coal for jobs over 35,000 sq ft EDR should be replaced by automatic stoking or conversion to fuel oil. The ancient rule of 30 cfm per pupil, which resulted in enormous ventilating systems that were not put in use, should be trimmed down to 15 to 20 cfm, and the necessary changes made. All ugly appearing exposed radiators together with unsightly wire mesh guards in entrances, vestibules and at stairs should be replaced by concealed radiation such as convectors. The existing two-pipe low-pressure mechanical vacuum systems are functioning satistorily.

The present practices of the Board of Education, Bureau of Construction, are quite satisfactory. All jobs are fired by No. 6 fuel oil. Class rooms are supplied with tempered air and the exhaust taken out through the wardrobe. Direct radiation, automatically controlled by a room stat, is in the form of concealed cast iron convectors under windows. The convector inclosures designed by the Bureau are strong, durable, and streamlined in appearance.

All outdoor air for ventilation should be filtered, which is not the present practice. Humidification should be added to all but blast systems such as for gymnasiums, cafeteria and auditoriums. This, too, is not the present practice.

The heating system is designed to be so flexible that special purpose rooms for community use after school hours, and for adult education, can be heated without having steam in the entire building. This is accomplished by a combination of special stream lines and the use of riser control.

Earl R. Andrix, Professor of Mechanical Engineering, Tri-State College, Angola, Ind.: All coal fired heating units should be provided with bin feed stokers. All heating units, coal, gas or oil, should be equipped with a not too complicated combustion control. Humidifying equipment, probably air washers, should be installed after the heater and should be controlled automatically.

Public utility power plants have gone in for a lot of supervisory control, remotely located recording instruments, etc. The matter of controlling the temperature, air velocity and relative humidity from a central point, as the principal's office, would be a relatively simple problem to a central station engineer.

Land for school buildings usually is not so expensive, so buildings can be of one floor design. Room radiators can be eliminated and temperature control obtained by booster fans in individual air ducts.

I have seen too many tempering coil air washer installations with insufficient heat in the coil and ice in the washer, not to feel strongly about this situation. Get the control and supervision away from the place it is now and give it to the automatic device under the observation of the principal or first grade teacher.

Andre Merle, Edgewater, Md.: The amount of the budget must be kept in mind along with state regulations and requirements. The term "heating" should be forgotten and consideration given the more modern approach through "climate conditioning."

Schools located in open country, small towns, counties, and small cities need less air cleaning, as a general rule, than similar schools within the larger cities. A supply of outside filtered air should be introduced for all direct radiation and recirculated warm air systems. If budget permits, an electrical filter should be used.

The features mentioned also apply to new construction. A central room, adjacent to the main building entrance and exit, should be provided with ultra violet lamps to kill air-borne germs.

Climate conditioning must be indirect in all warm air and cooling systems. When finances permit, use can be made of radiant heating with tempered conditioned air systems.

Under no condition should more than 5 lb steam pressure be produced for space conditioning or domestic hot water. Boiler plants and/or gas conditioning systems over 5 lb pressure should be installed in a separate building away from the school.

Carl Hobaugh, Butler, Pa.: Most of the present methods for raising room temperatures is still satisfactory if they are designed for economy and are provided with modern control instruments.

Since the present school year is from 8 to 10 months, it is doubtful if room air cooling is necessary in most sections of the United States.

Aside from a comfortable room temperature, the most important school need has been to promote a healthful condition in the class room. Health requirements in a school room can be largely met by controlling such factors as humidity, dust, oxygen, odors and air-borne bacteria. Thus far, this has

been largely accomplished through ventilation. As a result, many buildings are over-ventilated.

At present we have a great deal of knowledge and experience regarding humidity, dust and odor control. The application of this background is not difficult. Bacteria control will soon be a general practice by means of the sterilizing effect of certain lamps.

Teachers have always complained about the listless, drowsy pupil, but as yet little has been done to provide a uniform oxygen content.

It is probable that the school of the immediate future will be lighted, heated and sterilized and provided with health rays equal to those of the sun. In conjunction, there would be local or central equipment for exhausting undesirable gases, and for the control of dust, odor and oxygen content of the air.

Willis W. Howe, Sausalito, Calif.: Schools should have conditioned air to provide heating, cooling, filtration, humidification and ventilation for human comfort. Panel heating is probably one of the new developments that will occupy the center of the stage in the post-war period.

Leon Hand, Hyattsville, Md.: Heating systems in a great many of the schools are far from good and ventilation is worse. The univent system seems to be the only solution to this problem.

The design of heating and ventilating systems for post-war schools should, I believe, have an adaptation of the univent system with a central filter and washer for the air supply instead of a direct supply from the outside.

There may be a development of radiant heating systems for the so-called open air schools where one side of the room would be open the greater part of the time.

Frank L. Wadsworth, Sampson, N. Y.: In New York state I believe the present system used in central schools is satisfactory—a combination of direct radiation or convectors, together with univents in each room for ventilation. Air conditioning is unnecessary as schools are not used during the summer to any extent. Whether an oil-burning or coal installation is used is largely the matter of location—which of the two is more readily available and which is cheaper. Because of the difficulty of making repairs I do not favor radiant heating.

Eddie M. Nelson, Jersey City, N. J.: I am not in agreement with the present method of supplying heat in our schools.

The future school will not be heated through direct radiation in each room. Conditioned air will be provided. A central system of air distribution with branches to the individual conditioned spaces will allow adequate operation.

With such a system air can be washed, cleaned, purified, dehumidified, etc., at the air intake and distributed to rooms in zones from a central system. This air will pass through steam coils for heating and through sprays for humidification. It may also pass through an electrical device to remove the fine particles of dust, and through ultra violet rays to destroy bacteria. Such a system would eliminate the need for closing schools during mild epidemics.

Thomas F. Dwyer, Floral Park, N. Y.: For present buildings, hand firing should be replaced by low cost stokers or by an oil-burning installation. Schools should have a simplified system of temperature control to reduce fuel consumption.

In order to permit large quantities of air to be recirculated, ionization or a similar method of air treatment should be used. There should be simpler and more efficient means for cleaning air filters.

Outdoor stats used in temperature control systems should be improved in design to compensate for wind velocity and sun effect. Cast iron radiator design should be improved to combine the features of radiant heat and convector heat to permit all radiation to be recessed in walls, thereby eliminating free standing direct radiators.

P. A. Croney, Boston, Mass.: For a new school building I would recommend a controlled floor panel radiant heating system with central ventilation.

The controls would consist of a lock type, pneumatic, modulating, two-temperature room thermostat, having visible temperature scale, thermometer and day control range of 60-80F, with a night and week-end reduction of from 6-20F below the desired daytime setting. This control should have an individual key type manual reset for use of individual room control after automatic lowering of all thermostats from day-night clock in boiler room. These thermostats should be of the non-bleed type, minimizing the compressor operation.

These thermostats would operate modulating, pneumatic, three-way valves, proportioning the proper amount of design temperature to the radiant coils or around same to prevent mass lag of coils from overheating upon sudden occupancy of room. These valves should have positive positioning relays and position indicators, and bellows power units.

The automatic night reduction of all class room temperatures would be accomplished by the operation of relays through a time clock. This time clock would incorporate night shut-down and week-end skip mechanisms, as well as manual control for vacation periods. This clock would operate relays on the low and high pressure branch lines of the compressor and increase branch line pressure when night shut-down is desired, and decrease it for day control. The high branch line pressure is lowered by use of a relief relay, operating after lowered temperature period.

Ventilation would be supplied from a central system. Tempering coils would be controlled by a single seated, modulating, pneumatic, steam coil valve with accessories as described for the radiant heating valves.

There would be a modulating, pneumatic, remote bulb ductstat located in the discharge from vent coils, range 60-85F to modulate the valve.

Coils in the fresh air intake should be equipped with a felt edge, louvered type damper with bronze bearings and operated by a damper motor.

These motors should be operated by an electric-pneumatic relay which should feed and bleed air to and from the fan motor, and should close dampers from fan stops. This would also apply to the exhaust fans for the ventilating system.

Manual opening of ventilating and exhaust system dampers should be provided by the installation of manual switches on panel board in the boiler room to open dampers when the fan is inoperative.

The school should have a low pressure steam boiler plant, with interchangers for generating warm water for the radiant heating system, which steam would be used in the coils of the ventilating system.

LeRoy A. Melin, Chicago, Ill.: Existing systems should be provided with humidity control, air filters, and separate hot water heating, as gas or oil-fired, to be used for warm days instead of firing the boilers. Exhaust systems for toilets would be an improvement over old systems.

New designs should include air conditioning systems having compressors for cooling, humidifying an dehumidifying with automatic control. Sound deadening is important. Exhaust systems should be better than now exist in most class rooms, shops, laboratories and assembly halls.

Large schools should have automatic stokers. Draft fans would reduce the size of chimneys and would promote better combustion.

Kenneth E. Robinson, Bureau of Industrial Health, Michigan Department of Health, Lansing, Mich.: I believe that many of the heating systems now installed should have new controls, including zone controls where practical, as well as sufficient moisture added to insure proper humidity.

There has been a big improvement in all equipment regarding air movement, and in a good many schools new registers, controls and some changes in the ducts and heating coils would allow the present air that is introduced for ventilation only, to be used as a booster for the heater system, eliminating many cold exposures that often are the cause of students' complaints.

Thermostats should be relocated to insure proper temperature for the students. Many rooms occupied by small children are heated for the comfort of the teacher, and children on the floor are cool. If the heating is proper, both teacher and pupils will be comfortable.

Radiant heating will play a big part in the heating of new schools, I am sure. Rooms devoted to small children who play on the floor will probably be the first to have it. There is reason to believe that with panel heating, schools may be built to allow one side of the room to open, allowing classes to be held in the open air.

Certainly humidity, zone controls, and air movement with some method of disinfecting the air circulated will receive the attention due them. The control of these is required if proper comfort and health are to be maintained for the growing bodies subjected to the results of the installation.

Varying Refrigerating Compressor Capacity

The various methods of varying the capacity of refrigeration compressors were enumerated by Leon Buehler, Jr., Creamery Package Co., in a paper entitled "Capacity Reduction Methods," presented at a recent meeting of the Chicago section, American Society of Refrigerating Engineers.

Methods which require no special construction in the compressor, and by which capacity reduction is effected through external means, are:

Varying the compressor volume produced by multiple units through cutting out one or more compressors, or it can be done by the use of variable speed drives;

Throttling the compressor suction, such as with a back pressure valve;

Bypassing a portion of the discharge back to the compressor suction; and

Providing auxiliary heat to evaporate the excess available liquid refrigerant to balance the load to the plant capacity.

The last three of the foregoing methods result in a loss of the compressor's operating efficiency. Possible methods of reducing capacity by changing compressor design are: Use of variable clearance with one or more clearance pockets or clearance cylinders with movable pistons;

Designing a compressor with a variable stroke, i.e., the piston travels to within varying distances from the head or travels to the same point at the head but varying points at the crank end of the stroke;

Employment of a cylinder by-pass return to suction for a portion of the stroke;

Holding the suction valve open;

Use of a multiple cylinder compressor where individual cylinders are provided with independent heads. A connection from each head to a common discharge manifold is provided, and at least one of the connections is fitted with a check valve and connected to valved line from ahead of the check valve to the suction line, so that when the valve is open that cylinder will discharge back into the suction and in effect be out of service; and

A multiple cylinder compressor designed to permit selective operation of some of the pistons while holding others stationary could also tend to reduce capacity.

Isolating Vibrations in Mechanical Equipment

E. N. KEMLER and C. R. FREBERG
School of Mechanical Engineering, Purdue University, Lafayette, Ind.

ROTATING equipment, whether it be an electric motor, blower, engine, compressor, or similar machine, always has some degree of unbalance which sets up forces that may be transmitted to the supporting structure or foundation. These forces may produce objectionable noise or vibrations. Two fundamental methods can be used to eliminate such vibrations. The first is to reduce the unbalanced force to a minimum through use of counterbalance weights on crankshafts, static or dynamic balancing machines, or by improved design of the member. In many cases such changes will result in reduction of the disturbing force to the point where its effect is no longer serious or objectionable.

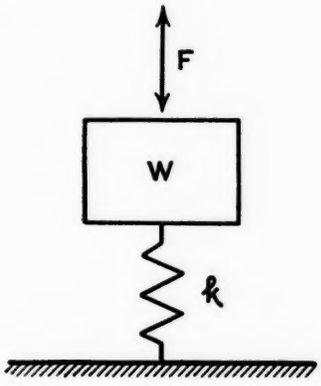


Fig. 1

Where the dynamic force cannot economically be reduced to the point where it does not cause trouble, the use of isolation mount or elastic suspension can usually be employed. Such mountings may be metal springs, rubber springs, cork, felt or similar materials placed between the machine and its supporting structure to reduce the effect of vibration. Before going into a discussion of how these mounts can be applied and calculated, a brief discussion of the nature of vibrations will be given.

A simplified vibration system which is elastically suspended or mounted can be illustrated by Fig. 1, in which *W* might represent the weight of an electric motor, compressor or similar piece of equipment. The spring, *k*, might be a spring suspension, rubber mounting, cork, felt, elastic beam, floor or similar method of support. It must be remembered that in some cases a floor itself will act as a spring, and while very stiff as compared with a felt pad, it still

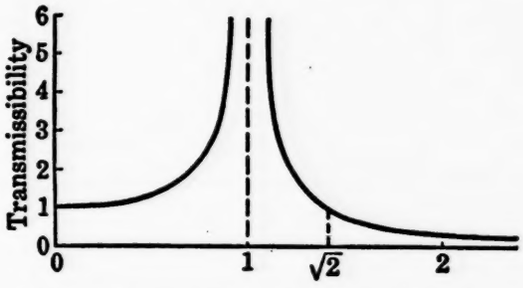


Fig. 2

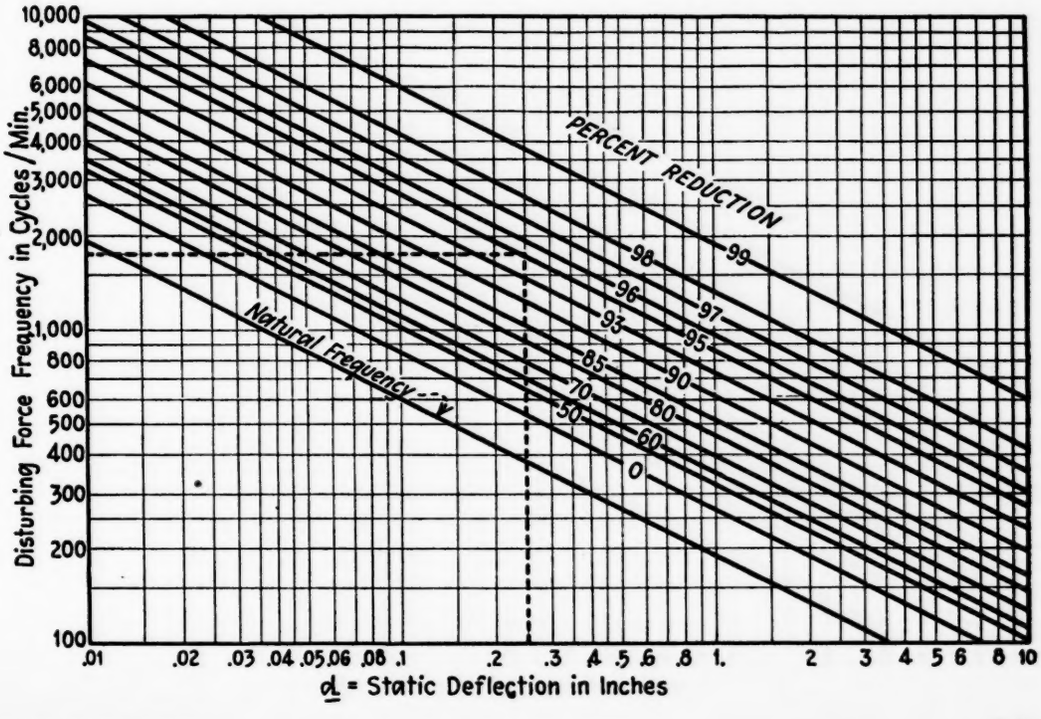
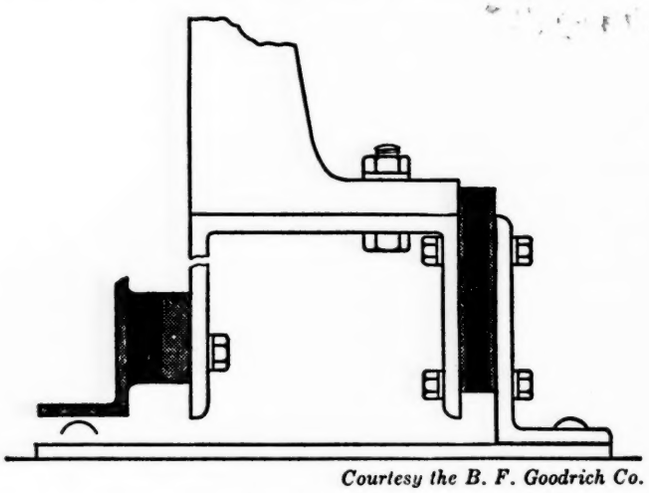


Fig. 3. Chart for determining the characteristics of a mount.

is an elastic member. The force F which is applied to this system may represent the unbalanced force on the rotor, or the unbalanced forces on crankshaft of a compressor. In the plane of motion this force

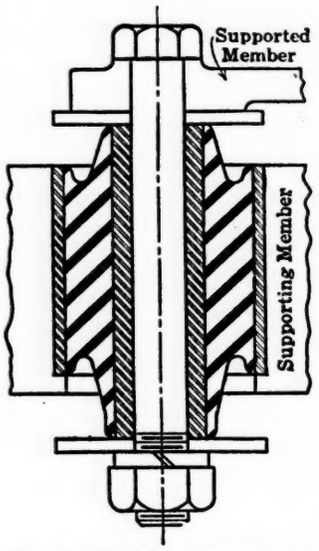


Courtesy the B. F. Goodrich Co.

Fig. 4

if plotted against time would have the form of a sine wave, varying about a mean value.

In isolating the vibration we are interested in knowing what part of this force is transmitted to the foundation. The ratio of the force transmitted to the foundation to the force F is called the transmissibility. This transmissibility really represents the amount the force is magnified or reduced insofar as the foundation is concerned, and when expressed so as to give a positive value is



Courtesy Lord Manufacturing Co.

Fig. 5

$$\text{Transmissibility} = \frac{1}{\left(\frac{N}{f_n}\right)^2 - 1}$$

where N is frequency of the force causing the disturbance; f_n is the natural frequency of the system under consideration.

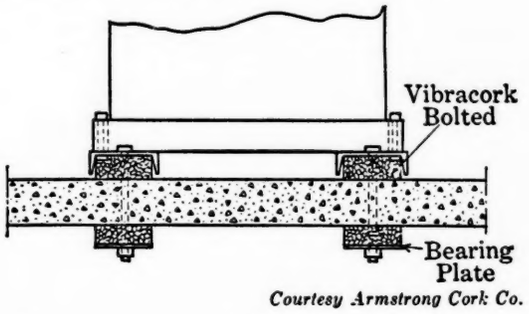
Fig. 2 shows a plot of this transmissibility against the ratio of the forced frequency to the natural frequency of the system, this forced frequency being the frequency of the force causing the disturbance. In the case of an electric motor, where the disturbing force may be caused by an unbalance in the motor rotor, the forced frequency will be the motor rpm. These frequencies can be expressed in revolutions of cycles per minute or per second as desired. Both must, however, be kept in the same units.

An analysis of Fig. 2 is very important in determining the characteristics of the mounting system. It can be seen that when the frequency of the force causing the disturbance is low as compared with the natural frequency of the system that the transmissibility is 1. This means that all of the force is transmitted to the foundation. As the frequency of the disturbing force increases the transmissibility increases and reaches a maximum when the frequency of the disturbing force equals the natural frequency of the system. If now we assume a constant frequency for the disturbing force, the transmissibility decreases as the natural frequency of the supporting structure decreases. When the frequency of the disturbing force equals $\sqrt{2}$ times the natural frequency of the supporting structure, the transmissibility again becomes 1 or the magnitude of force transmitted to the foundation or support is again equal to the force causing the disturbance. It is obvious that a support which would have a natural frequency so as to cause the ratio of force frequency to the natural frequency to be less than $\sqrt{2}$ would result in a greater force being transmitted to the foundation than if the machine was mounted on a rigid foundation.

If then the type of mount is to give a reduction in force below the value for a rigid mount, the natural frequency of the elastically supported unit must be small as compared with the frequency of the forced vibration. For low speed machinery this frequency causes difficulties. Remember, an improperly designed mount may be much worse than no elastic mount.

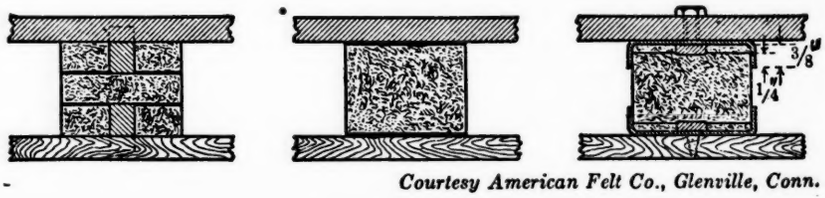
Fortunately many of the commonly encountered mounting problems with motors, fans, small compressors, etc., can be solved by reference to a simple chart. This simple chart can be used because it can be shown that for a simple system the natural frequency can be written in terms of the amount the support deflects under the weight of the body to be isolated.[1] The amount which the support deflects under the action of the body weight is called the

[1] C. R. Freberg and E. N. Kemler, "Elements of Mechanical Vibration"—John Wiley & Sons, Inc. Pp. 19 and 93.



Courtesy Armstrong Cork Co.

Fig. 6



Courtesy American Felt Co., Glenville, Conn.

Fig. 7

static deflection and analytically can be written as

$$d_{st} = \text{static deflection} = \frac{W}{k}$$

where k = pounds load needed in elastic support to deflect it 1 inch.
W = weight of mass that will vibrate.

In designing the isolation mount it is desirable to express the type of isolation as the percent reduction desired. For example, a 90% reduction in force transmitted would mean that only 10% of the disturbing force will be transmitted.

Fig. 3 gives a chart for determining the characteristics of a mount to give any desired amount of isolation. If the frequency of disturbing force is known and the percentage reduction in force to be transmitted decided upon, the static deflection can be determined immediately. As an illustration, consider the case where it is desired to determine the characteristics of a mount for an electric motor driven rotary pump unit running at 1,760 rpm when it is desired to isolate 95% of the disturbing force. We enter Fig. 3 at the left for frequency of the disturbing force equal to 1,760 rpm, trace across to 95% reduction, then down to lower scale and read that what is needed is a static deflection of 0.25 in. when the motor and pump unit is set on it. As far as the isolation of the force is concerned, the type mount or support used to get this deflection is not a factor. For example, it might be convenient to use 4 isolation units instead of one. The load each will carry will be ¼ of the total. The static deflection under the ¼ load must still be the same as if a single isolator were used. There are however other factors to be considered which will be discussed later.

The analysis given is elementary and considers only the main factors. The fundamental basis for calculating simple vibrating systems is that which has been outlined. The problem of deciding the type mount or designing springs for the desired deflection is in general much more of a problem than the

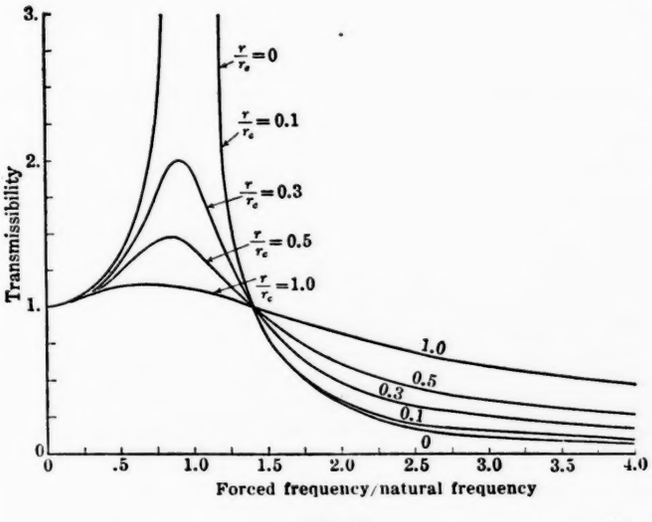
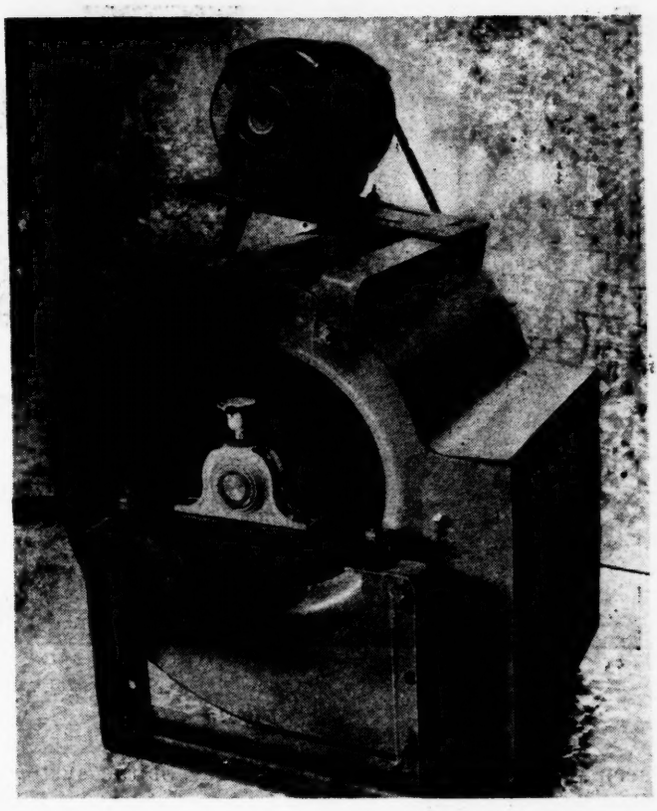


Fig. 8

Values of r/r_c is the ratio of actual damping constant to critical damping. It indicates curves of various amounts of relative damping. The higher this value is, the larger the amount of damping.



Courtesy, U. S. Rubber Co.

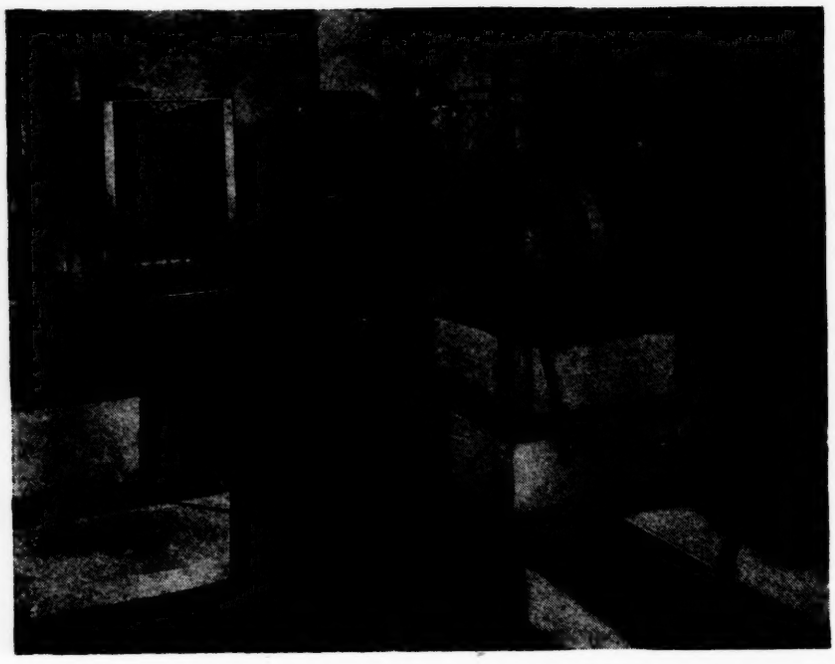
Fig. 9

determination of the characteristics of the system. For more involved analysis, reference should be made to texts on vibrations.

In selecting the type of isolator or elastic member there is a wide choice of materials, manufacturers and designs. Metal springs are adaptable to all types of problems but are particularly used in connection with heavy equipment. The use of metal springs alone is not desirable where noise transmission is undesirable. For small and moderate sized applications, rubber isolators are commonly used. Figs. 4 and 5 show two types of designs which have been used. There is a wide variety of isolators available and the type to be used will depend upon the application. Cork is frequently used with heavy machinery. Fig. 6 shows a typical application of cork for smaller machines. Felt is usually limited to problems involving high speed machine isolation. Like cork, it has good sound isolation properties. Fig. 7 illustrates different methods of mounting on felt to prevent sidewise motion.

In certain cases other methods of vibration absorption can be introduced. Most of them, such as the dynamic absorber, become quite complicated and require detailed analysis of the problem. Some of these methods are quite practical and where they can be applied, may be more effective than the use of isolators.

This discussion has not considered friction dampers or shock absorbers. Where an isolation type mount is to be used at high frequency ratios, it is important to keep friction out of the system. Fig. 8 shows a plot of transmissibility against the same frequency ratio as in Fig. 2. In this case curves for various amounts of damping have been given. It can be



Courtesy, Armstrong Cork Co.

Fig. 10

seen that near the natural frequency of the system that damping is effective in reducing the force transmitted. However, in the range where the isolation type of mount is used, the effect of friction in the system is to increase the force transmitted to the foundation. When designing a good isolation type of mount, don't use any friction device. If, however, the unit may operate near the natural frequency, some type of friction damper may be highly desirable. Normally it is not used unless absolutely necessary.

Figs. 9 and 10 illustrate two typical examples where isolation types of units have been used to reduce the forces and vibrations transmitted to surroundings. Fig. 9 is an example where a rubber type isolation unit was used to eliminate the possibility of vibration and noise being transmitted from blower spider to blower housing and subsequently along air ducts; Fig. 10 shows an application of cork for the isolation of compressor and pumps from their foundation. This installation was on the sixth floor of a department store.

Design Problem

Example. A motor driven fan is to be isolated from the rest of the air-conditioning system. The direct connected motor operates at 1,760 rpm. If four isolators are to be used, what size should be selected to give effective isolation?

Solution. The amount of isolation which is needed will depend upon the magnitude of force causing vibration and the requirements of the particular installation. For the average installation, 80% isolation is usually sufficient for good results. Where noise and vibration isolation is very important, 90 or even 95% isolation may be required.

Reference to Fig. 3 shows that a static deflection of 0.065 in. is needed to give 80% isolation. This is approximately 1/16 of an in. Each isolator is assumed to carry ¼ of the load or 10 pounds. The selection of an isolator then requires an isolator which will deflect 1/16 in. or more under a 10 lb load. In general this is the only requirement which is placed on the isolator. Its size, shape, style, etc., are not particularly important. A steel spring which will meet these requirements would be satisfactory. If, however, noise transmission is a factor, rubber, cork, or felt might be more desirable. The proportions of a spring type isolator can be determined by reference to a mechanical engineering handbook. For other types of isolators reference must be made to manufacturers' catalogues.

The Lord Manufacturing Company lists a number of plate form isolators as shown in Fig. 11. These are abstracted in part from the company's Bulletin No. 103. It can be seen that a number of forms of isolators of this particular make are available. Other manufacturers make equivalent isolators of other designs but which if selected according to the principles set forth will do the same job. The selection of the size of unit can be made from Table 1 which shows in part the capacities of isolators available. This table shows that a 10 lb load rating unit to give 1/16 in. deflection under this load is available. This is a 102 series isolator. The table shows that a 3/32 in. deflection under a 10 lb load can be obtained with a 153 series isolator. This later unit would give greater than 80% isolation. Reference to Fig. 3 shows that the 153 series isolator would give about 88% isolation.

This particular example shows how an isolator for a particular job can be selected. In general the same procedure can be used in the selection of isolators of other types by other manufacturers.

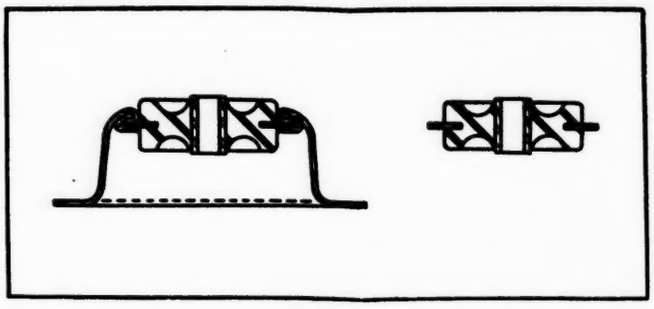


Fig. 11

Cross-sections of mountings for load ratings in the 102 series and for the high shoulder mountings which have the lower load ratings in the 153 series of the Lord Mfg. Co.

TABLE 1

Defl. Under Load	Load Rating, Lbs.	Defl. Under Load	Load Rating, Lbs.
102 Series		153 Series	
	1		6
	2		8
	3		10
1/16"	4		12
	6		15
	8	3/32"	20
	10		24
	12		28
			33
			39
			45

Some Experience Data on

Snow Melting by Underground Pipes

T. NAPIER ADLAM
Vice-President, Sarco Company, New York.

In the August 1944 issue of HEATING AND VENTILATING Mr. Adlam described, in an article titled Farewell to Snow Shoveling, a heated footpath at the Sarco Bethlehem (Pa.) works, with hot water pipes buried beneath the walk to melt snow as it fell. Because of the unusually large amount of snow coupled with severe cold weather during the 1944-45 winter, the operating data of the walkway presented here are of particular interest.

THE heaviest snow storm experienced this past winter in Bethlehem was a 14 in. fall on January 16, 1945, and the unretouched photograph, shown in Fig. 1, was taken immediately after the snow ceased and at a time when the outside temperature was falling rapidly.

It will be noted from the photograph that a building has been erected to the left of the footpath which did not exist when the original photograph, shown in the August issue, was taken.

At no time during this heavy snow-fall, or during any other snow storm, was there any unmelted snow on the footpath, except at a few isolated spots close to the building, as can be seen in the picture, Fig. 1. These small patches are places where snow alighted on small pieces of wood and other debris which had fallen from the new building under construction. These were purposely left in the picture to illustrate that while the heat reaching the surface of the concrete was sufficient to melt all snow falling on the heated area, the heat from the concrete was not sufficiently intense to penetrate the debris to melt the snow. This was undoubtedly due to the very low outside air temperature which rapidly dissipated the surplus heat. Every other part of the footpath was perfectly free of snow and has been throughout the winter. The heaviest rate of snow-fall recorded was approximately 1.062 in. per hour, all of which melted as soon as it reached the concrete surface.

The small accumulation of water on the footpath, which can be seen about midway on the photograph, is due to a slight incline on the concrete slab—toward the side wall at this point, caused by a sinking of the slabs during excavation for the foundation of the

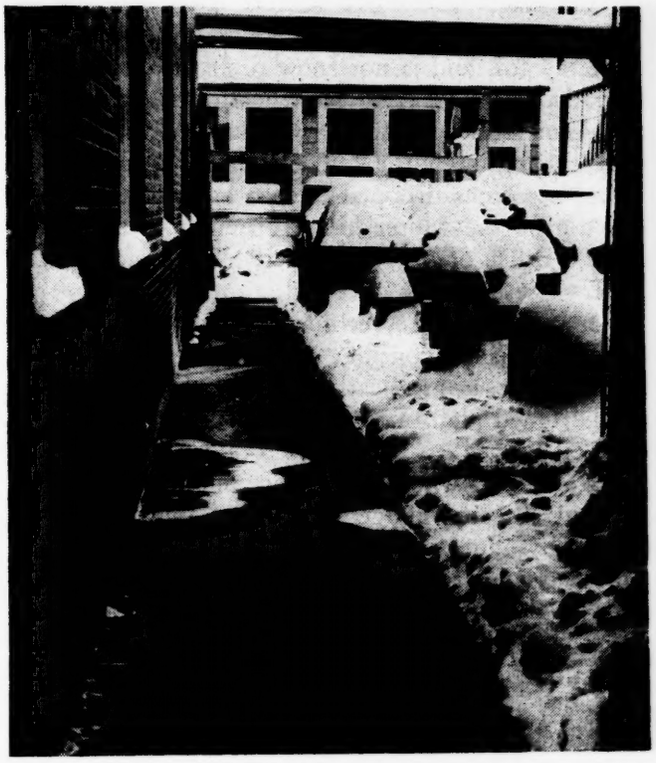


Fig. 1. Heated footpath from the factory to the cafeteria, from a recent unretouched photograph. This view compares with Fig. 4 of the article in the August 1944 issue.

TABLE 1.—TEMPERATURE DATA FROM HEATED WALK
(Letters refer to locations in Fig. 2)

Outside Air Temp., F	Surface Temperature, F, at Points Directly Above Pipe											Surface Temperature, F, at Points Between Pipe						Surface Temp., F, of Bare Ground
	A	B	C	D	E	F	G	H	J	K	Average	1	2	3	4	5	Aver.	
34	61	58	55	53	48	52	49	51	56	56	54	58	56	51	48	50	52.6	35
28	56	53	51	49	41	46	42	47	53	52	49	52	47	46	43	44	46.4	28
32 (D)	59	56	53	52	48	50	48	50	54	53	52.3	56	54	49	48	49	51.2	33
32 (W)	35	35	34	34	34	34	34	34	35	35	34.4	34	34	34	34	34	34	32
0	33	30	29	28	26	29	26	33	35	36	30.5	29	26	26	24	25	26	2

(D) = Dry Surface (W) = Wet Surface

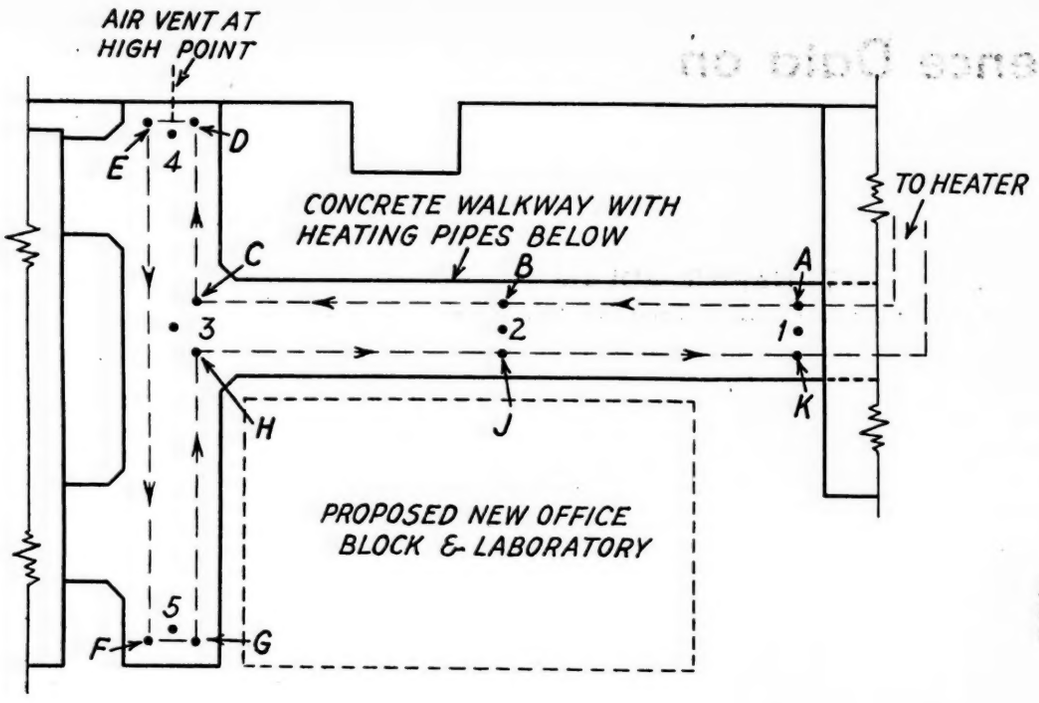


Fig. 2. Plan of walk showing locations of temperature stations, readings from which are shown in Table 1.

new building. The white surface around the edge of the water is due to the reflection of snow on the cafeteria roof, and is not snow or frost on the footpath. At no time during the whole of the winter has any ice or frost collected on the surface of the footpath, even though the outside temperature has on several occasions dropped to zero and below. At no time during the winter has it been found necessary to use a brush or any other method to remove snow or ice, since none has collected.

A few temperature records may be of interest to those who wish to consider this problem further and, for the purpose of indicating surface temperatures, a foreshortened plan of the footpath is given in Fig. 2 which is keyed to Table 1. Points indicated by letters are spots where the surface temperatures were recorded directly above the pipes, and points indicated by numbers are spots where surface temperatures were recorded between the pipes. It will be noted that in most cases the surface temperatures of the exposed earth taken some distance from the footpath followed the air temperature very closely, while the surface temperature of the heated slabs was affected by both the air temperature and the temperature of the heating medium.

When taking surface temperatures with snow falling heavily on the surface, it was found that the surface temperature dropped to an average of 34F, but within a few minutes after the snow ceased, the surface temperature rose 5F or 6F, even though the surface was still wet.

The third and fourth rows of temperature records indicate the surface temperature taken with dry and wet surfaces, respectively. These temperatures were taken under exactly the same conditions of outside air temperature and pipe coil temperature.

As regards thermal efficiency, the following records may be of interest: With a dry outside air of zero temperature, approximately 55.1% of the heat given to the heating medium was given off by the surface of the concrete. This was reduced to 46.3% with an air temperature of 32F. With snow falling at the rate of 1.062 in. per hour, approximately 70% of the heat given to the heating medium was usefully used to melt the snow, and a further 10% was given off to the surrounding air and cold surfaces.

During the past winter much interest was created with this method of snow and ice removal because of the large amount of snow and the formation of ice due to very cold weather experienced.

We are satisfied that heating pipes correctly installed beneath any outside surface will effectively eliminate snow and ice, even under the worst conditions. This should prove very advantageous not only for footpaths, driveways, gas stations, approaches to public buildings, including steps, and so forth, but also for runways of large airports.

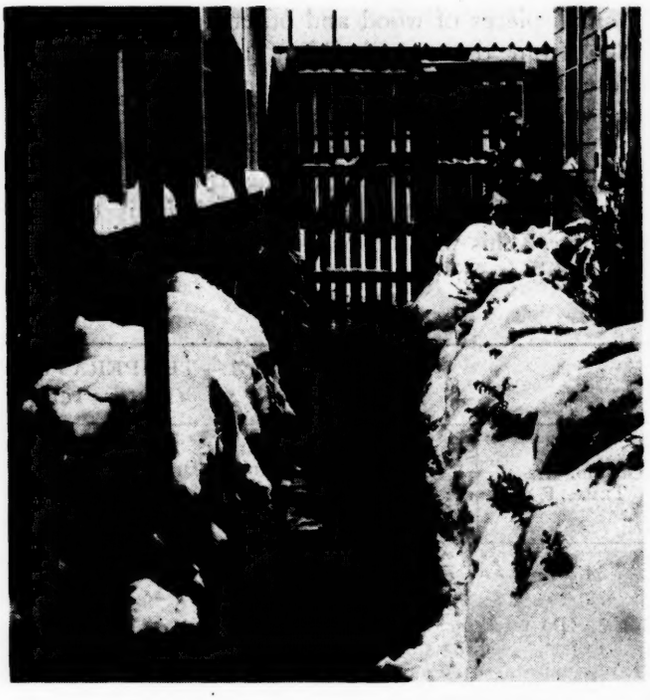


Fig. 3. Another view of the heated walk.

We find it is not necessary to keep the heat circulating in the pipe coils at full temperature at all times, but it is more efficient to maintain a moderate heat during periods when snow is predicted, and then boost the temperature immediately snow starts to fall, than it is to rely on heating up the whole of the runway from cold at the time snow commences.

From our investigations the writer estimates that to eliminate all snow from a runway 1000 yards long by 100 feet wide under the worst weather conditions, would require approximately 72 tons of coal per 24 hours, or an equivalent to this in fuel oil.

The cost of snow removal by using buried heating pipes compares quite well with the usually high cost of removal by mechanical and labor methods, which sometimes is as much as $200,000 annually for large airports.

Furthermore, with the heated surface method planes can land and take off as the snow melts. When using mechanical methods some parts of the runway are being covered with new falling snow while the other part is being cleaned. The melting of snow on the runways will not only prove much safer for landing because the runways will be easily discernible from the plane, but the surface will also be safer for both taking off and landing of planes at high speed, as there will be no fear of slippery surfaces due to the formation of ice.

It is estimated that during an average winter it will be found necessary to take care of snow-falls for not more than ten to fifteen days at full power, and for no more than 60 to 70 days at less than 50% full power during periods of predicted snow-falls.

The cost of fuel to maintain these conditions should be more than balanced by the saving effected in revenue by not having to cancel or rearrange schedules, which becomes inevitable under present conditions when heavy snow-falls occur.

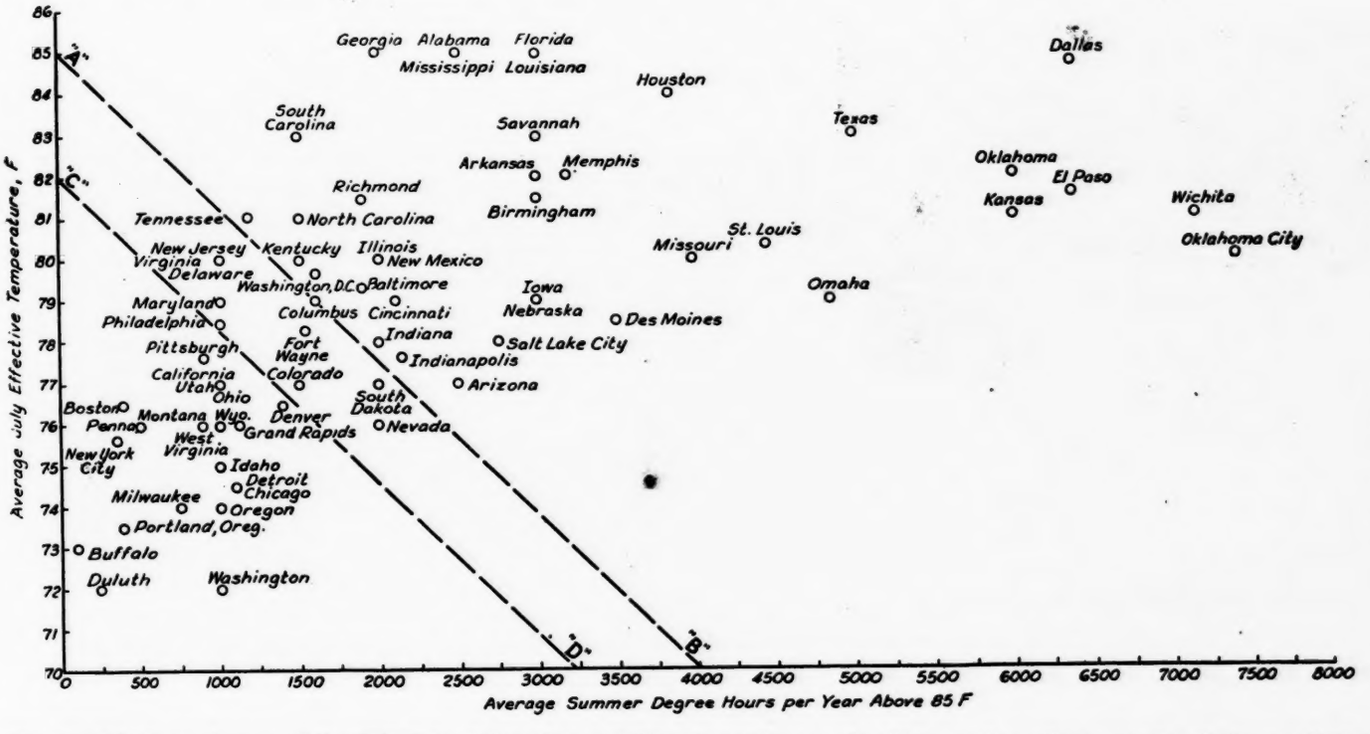
Deciding Relative Geographical Need for Air Conditioning

A year ago, when there was a decided shortage of Freon, the War Production Board was faced with the problem of allocating Freon for air conditioning, including the recharging of existing systems. The accompanying chart shows a graphical guide prepared by the Office of Civilian Supplies and War Production Board in cooperation with the U. S. Public Health Service to determine in what areas use of Freon was allowable.

The graph shows a plot of summer degree hours above 85F plotted against average July effective temperature. States and cities were located on this grid, and the lines AB and CD selected by judgment as the boundaries of three zones. Locations falling to the right of AB were considered to be in more urgent need than those to the left. Those between AB and CD were problematical, depending on individual conditions, while those in the lower left corner were extremely doubtful, and the use of Freon severely restricted for such localities.

Those locations at the extreme right on the graph are ones having the greatest need for air conditioning according to this reasoning.

The graph is presented through the courtesy of V. C. Kylberg, who, with others, was responsible for the compilation of data and design of the graph.

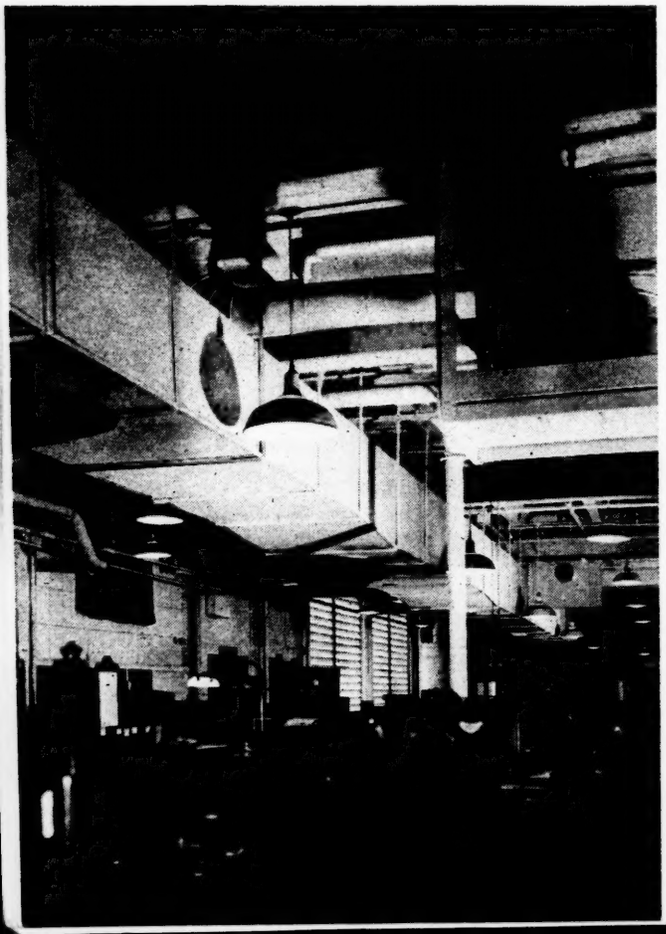


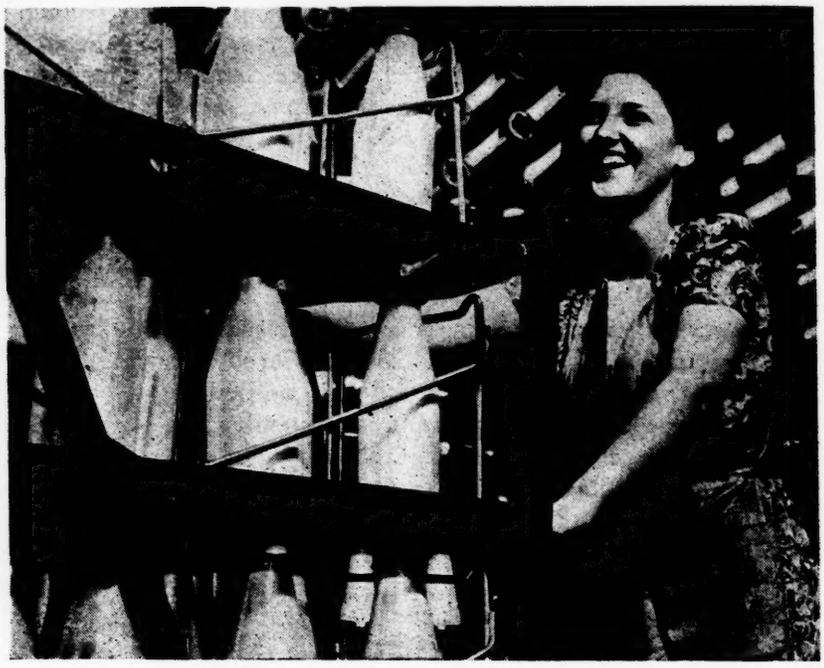
Geographical zoning used by WPB to determine relative importance of cities and regions as to their need for air conditioning.

Picture Paragraphs

Photo taken on the trial run of the "Frederick Victory," U. S. Maritime Commission vessel (and showing a Breidert exhauster used for ventilation of space below the decks.

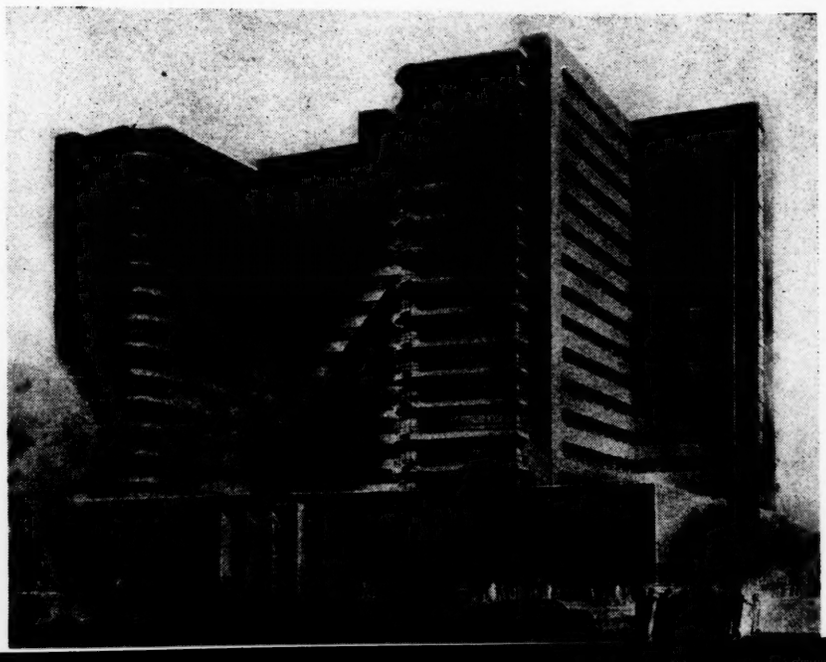
Westinghouse air conditioning equipment was installed in the company's small-circuit breaker assembly room at East Pittsburgh, Pa., to maintain the temperature at 70F the year around. Because of wartime restrictions on metal, air ducts were built with fiberboard with metal used only for hangers and supports. Air conditioning speeded output 31%.





In the weaving of glass cloth, the glass fiber yarns are made of more than 100 almost invisible filaments drawn from molten glass. These filaments are sensitive to humidity and temperature fluctuations. A total of 36 Carrier Industrial humidifiers were installed at this plant.

Preliminary plans for the proposed new Kahler General Hospital at Rochester, Minn., call for an 18-story structure to be the first all welded building of that type in this country. It will cover an area 150 by 270 sq ft or about one-half a city block, have welded steel construction and concrete floor slabs.



Some Properties of Flash Steam and How to Handle It

C. H. KOPER
Engineer, B. F. Sturtevant Co., Inc., Cleveland, Ohio

THERE is no difference between steam generated at the source of generation and flash steam created at the point that water of condensate under steam pressure is discharged from one pressure area into a lower pressure area. Characteristics of both steams are practically the same at the same pressure, except that the flash steam may be slightly more saturated.

Steam has some very peculiar characteristics as shown in Fig. 1. The volume per pound of steam at pressures less than atmospheric increases very rapidly as the vacuum increases, but it is just the reverse at pressures above atmosphere. Volume decrease is slower as the pressure increases.

The Btu per cu ft increases at practically a constant ratio as the pressure increases. Boiling point temperature of water at various pressures is not constant with either volume or Btu of evaporation at various pressures.

When steam is generated it is conveyed and used immediately—not stored. When the latent heat of evaporation is dissipated from steam, the resultant water of condensate has the same temperature as the steam and will remain at approximately the same temperature as the steam as long as it remains in the presence of the steam.

When water of condensate under steam pressure is discharged through a trap into a lower pressure area, the temperature of this water of condensate must and will immediately drop to the temperature of the boiling point of water at the new low pressure.

When this high temperature condensate leaves a trap, the result is the equivalent of an explosion right at the trap orifice, and is a mixture of steam and numerous water droplets. These droplets continue to explode in rapid succession until the water of condensate finally is reduced to the boiling point or less of water at the existing pressure in the return piping.

Water of condensate, when this process is completed, will settle down and flow peacefully along the bottom of the pipe if high velocity steam does not disturb it.

The percentage of flash steam created depends upon how great the pressure difference is between the two pressure areas as shown in Figs. 2 and 3.

Fig. 2 gives the percentage of the water of condensate discharged that will flash into steam when discharged into areas of atmospheric pressure or less.

Fig. 3 gives this percentage for atmospheric and 10 lb back pressure.

Flash steam can be wasted or utilized. In either case it can be a source of considerable trouble and annoyance, particularly through water hammer. A water hammer is not only an annoying noise but it can be the cause of a lot of trap trouble, particularly so where high pressure steam is used.

Water hammer is caused by only one thing—a body of steam between two bodies of water. This condition is brought about by a water pocket in the steam or return piping system or steam moving at a high velocity over the top of the water of condensate flowing along the bottom of the pipe, and whipping it into waves.

This water of condensate may be flowing in the same direction as the steam or in the opposite direction. When steam and water of condensate travel in opposite directions, the water will be whipped into waves at a lower velocity than is required to whip it into waves when both are traveling in the

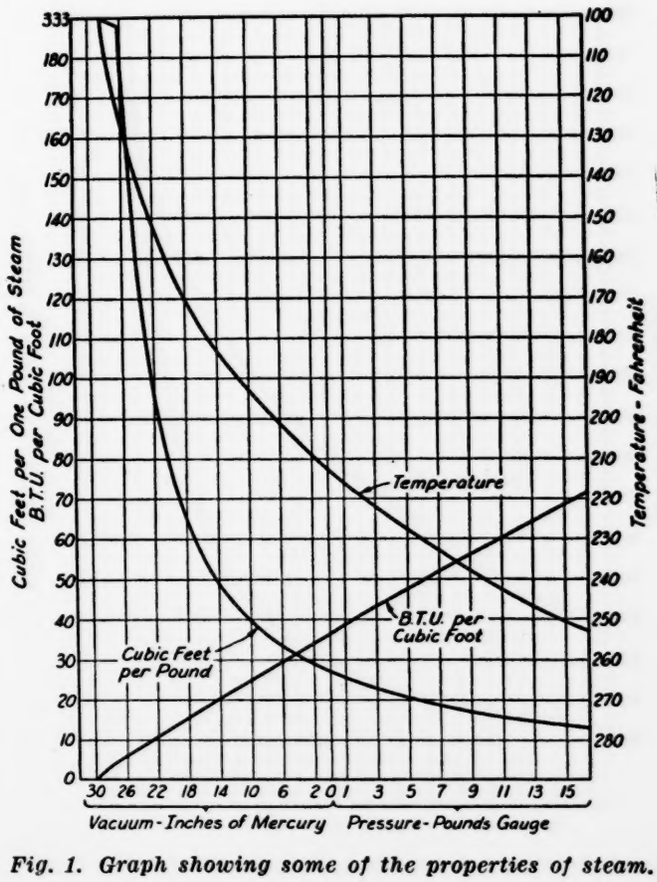

Cubic Feet per One Pound of Steam
B.T.U. per Cubic Foot
Temperature - Fahrenheit
Temperature
B.T.U. per Cubic Foot
Cubic Feet per Pound
Vacuum - Inches of Mercury
Pressure - Pounds Gauge

Fig. 1. Graph showing some of the properties of steam.

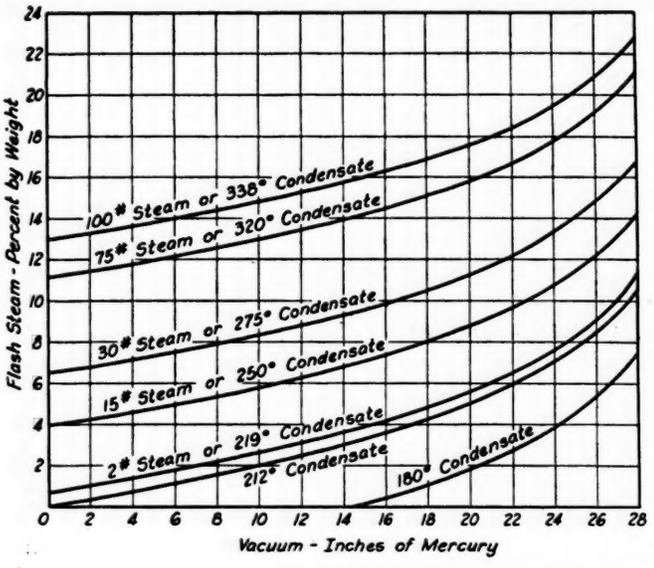

Flash Steam - Percent by Weight
100# Steam or 338° Condensate
75# Steam or 320° Condensate
30# Steam or 275° Condensate
15# Steam or 250° Condensate
2# Steam or 219° Condensate
212° Condensate
180° Condensate
Vacuum - Inches of Mercury

Fig. 2. Flash steam in per cent per pound of condensate for various pressures and temperatures.

same direction. The former occurs most frequently in one-pipe steam heating systems, and the latter in the return piping system of two-pipe trap systems, particularly where high pressure steam is used.

This high velocity of steam may be caused by improperly designed or installed piping systems, or excess steam in the return system of piping of a two-pipe trap system.

This excess steam in a return system of piping is caused by defective traps passing steam, or a great pressure differential between the steam side and return side of traps.

As an example, assume a 15 lb steam system with a vacuum return. A 20 in. vacuum is maintained in the return piping system. The condensate load of one piece of equipment is 200 lb of steam per hour.

Fig. 2 shows that 9% of the water of condensate by weight, discharged into the return through a float or bucket trap, will flash into steam or vapor.

Nine percent of 200 lb is 18 lb of flash steam or vapor per hour. Fig. 1 shows that this flash steam or vapor has a volume of 75 cu ft per lb, or a total of 1350 cu ft, and contains 13.5 Btu of evaporation per lb, or a total content of 18,225 Btu per hour.

The velocity of 1350 cu ft per hour in a ¾ in. pipe without the presence of any water of condensate is 6,080 fpm or more than 60 miles per hour. Under the same condition, the velocity in a 1 in. pipe is 3,750 fpm or 42.6 miles per hour, and in a 1¼ in. pipe 2,160 fpm or 24.5 miles per hour. If the water of condensate filled half the gross area of these pipes, the velocity would be double that given.

The Btu content of steam or vapor under 20 in. of vacuum is 13.5 Btu per cu ft as shown in Fig. 1, or 0.00786 Btu per cu in. A cu in. steam pocket between two water waves in a 1¼ in. pipe is a big area in proportion to the pipe area and it does not take long to radiate and for water to absorb that small quantity of heat. The result is a sudden, almost perfect vacuum between the two waves of water that touch the top of the pipe to form the pocket and they are brought together with a great force, and considerable noise. The higher the steam pressure of a steam system with a vacuum return, the lower the vacuum should be.

A vacuum return system should never be used in connection with a high pressure steam system. In fact, the return should carry a low gauge pressure, if there is sufficient high pressure steam condensed and the flash steam used for heating or low steam pressure processing. See Fig. 4.

As an example: Assume a high pressure load of 3000 lb of steam per hour, equal to approximately 100 boiler horsepower, and the steam pressure is at 100 lb gauge pressure. Ten pound back pressure is to be maintained in the high pressure return system.

Fig. 3 shows that 10% of this 3,000 lb of water of condensate will flash to steam when discharged through a float or bucket trap into 10 lb back pressure.

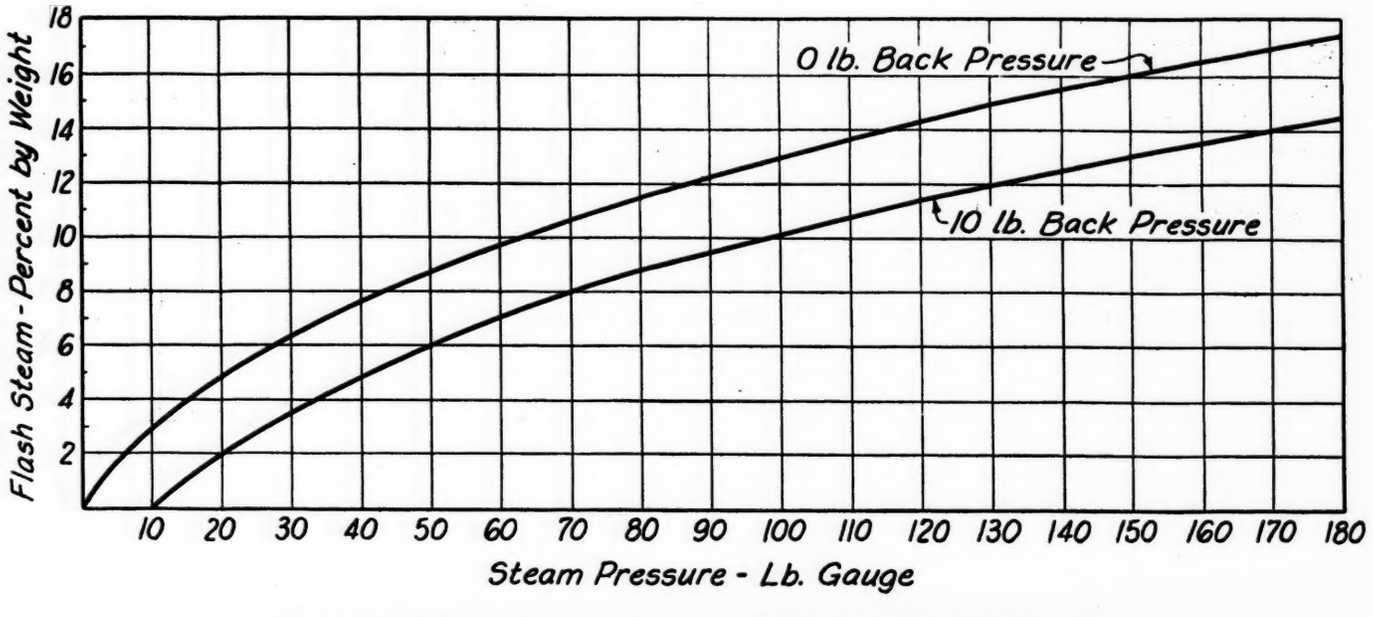


Fig. 3. Flash steam in per cent per pound of high pressure condensate.

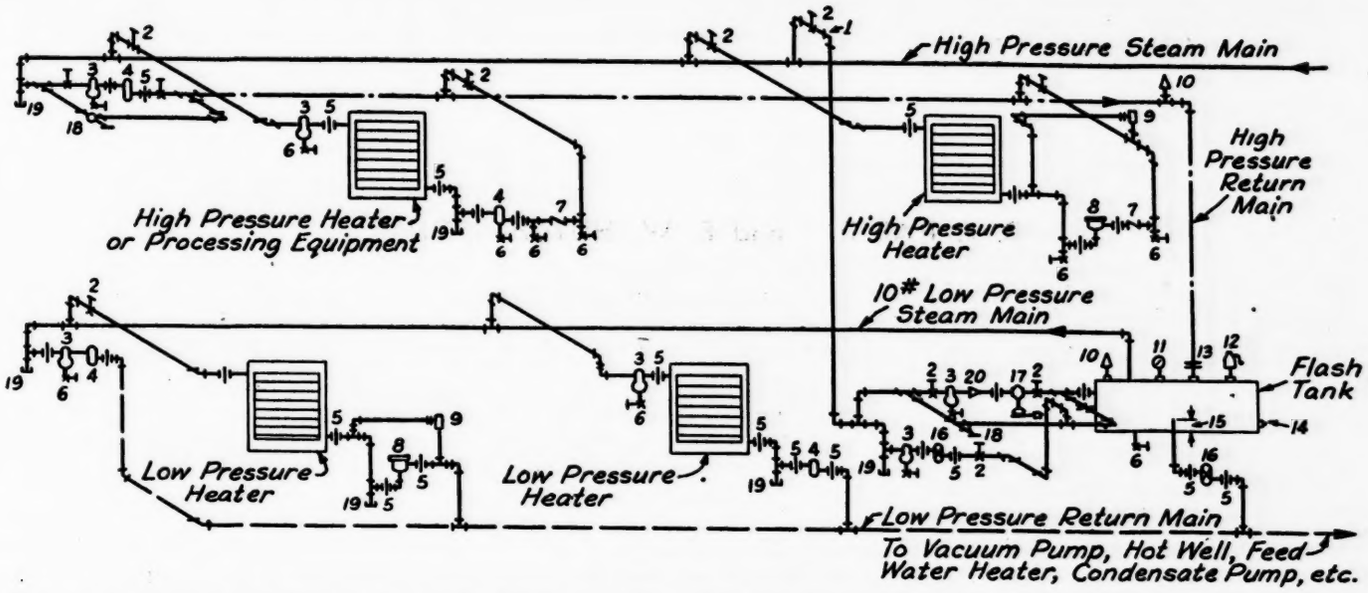

High Pressure Steam Main
High Pressure Heater or Processing Equipment
High Pressure Heater
High Pressure Return Main
10# Low Pressure Steam Main
Flash Tank
Low Pressure Heater
Low Pressure Heater
Low Pressure Return Main
To Vacuum Pump, Hot Well, Feed Water Heater, Condensate Pump, etc.

Fig. 4. Flash tank installation designed by author. Capacity of low pressure heating equipment should not exceed 75% of total flash steam. Numbers in drawing are keyed as follows:

1—High pressure steam to flash tank
2—Gate valve
3—Strainer with drain valve
4—Float and thermostatic trap
5—Union
6—Drain valve
7—Check valve
8—Inverted bucket trap
9—Thermostatic trap (air by-pass)
10—Large port air vent
11—Pressure gage
12—Safety valve set at 15 lb
13—Flange union
14—Inspection plug
15—Extend return connection into tank ¼ diameter of tank
16—Float trap
17—Pressure reducing valve
18—By-pass and by-pass angle valve
19—Dirt pocket
20—Reducing coupling

Fig. 1 shows that steam under 10 lb pressure has a volume of 16.3 cu ft per lb, or a total of 4,890 cu ft, and contains 952 Btu of evaporation per pound, or a total of 285,600 Btu per hour.

This 285,600 Btu per hour is equal to 8.65 boiler horsepower, and is available for heat or processing at no increase in fuel consumption.

In utilizing flash steam, the selected low pressure steam load should not exceed 75% of the estimated flash steam. Existing conditions will dictate whether this percentage should be increased or decreased. The 25% allowance in above percentage is for pipe condensing load. As an emergency it is well to make a high pressure steam connection to flash tank through a reducing valve.

In designing a return piping system for a high pressure steam system, ample pipe cross area must be provided or the high velocity of the flash steam over the water of condensate in the return pipe will be whipped into waves and the results will be a water hammer.

Until some definite experiments are made to determine the maximum possible velocity in return piping without whipping the water of condensate in the bottom of a horizontal pipe into waves large enough to cause a water hammer, all that can be done is to guess in proportioning the return piping system of a high pressure steam system.

Allowing a 1,000 ft velocity for the full area of the return pipe for the estimated flash steam volume has proven satisfactory. Allowing the water of condensate to half fill the pipe diameter, the maximum velocity would then be 2,000 fpm, or 22.7 miles per hour.

Following through with this high pressure steam example, the 300 lb of flash steam at 10 lb pressure has a volume of 4,890 cu ft.

The velocity of this 4,890 cu ft per hour in a 2 in. pipe without the presence of any water of condensate is 3,500 fpm, or 39.8 miles per hour. Under the same condition, the velocity in a 2½ in. pipe is 2,455 fpm, or 28 miles per hour; in a 3 in. pipe 1,589 fpm, or 18.06 miles per hour; and in a 4 in. pipe 922 fpm, or 10.48 miles per hour. If the water of condensate filled half the cross area of these pipes, the velocity would be double that given.

Large pipe sizes are recommended where there is a considerable quantity of flash steam, but this does not mean that the trap tapping should be extra large, or larger than on commercial traps. It is good practice to have a short run of about 2 ft on the discharge side of a trap the same size as the trap tapping, except where the return main is above the trap. Then the vertical line should also be the same size as the trap tappings, and the line increased at the first elbow.

This small diameter vertical pipe permits flash steam to elevate the water of condensate in the pipe without a serious water hammer, because the extra high velocity, which causes an increased back pressure and is maintained in the return piping system, retards the flash to the point where the pipe increases.

This extra high velocity which causes an excess back pressure near the trap orifice is the cause of much trap trouble, particularly so when piping the same size as the trap tapping is extended for too great a distance. Always make due allowance for any and all back pressures in selecting traps.

Graphical Determination of Heat Transfer Film Coefficient for Liquid Freon-11†

B. F. RABER** and F. W. HUTCHINSON***

Example: A Freon-11 heat exchanger consists of a bundle of 3 in. nominal diameter extra-heavy wrought iron staggered tubes with liquid flowing in the tubes at a velocity of 3 feet per second and cooling from an average temperature of 50F. Outside, and flowing normal to the tubes, is liquid Freon-11 at an average temperature of 35F and with a velocity through the narrowest cross-section between the tubes of 4 feet per second. Determine the rate of heat transfer per lineal foot of tube and compare it with the heat transfer rate which would exist in an exchanger having the tubes in-line and with the same spacing between tubes at the narrowest section. The inside and outside diameters of 3 in. extra-heavy wrought-iron pipe are 2.9 in. and 3.5 in., respectively.

Solution: The inside film coefficient is found from Fig. 11 by entering the velocity scale at 3 feet per second, rising to an interpolated horizontal for 2.9 in. I.D., following the directrix to the base scale, rising vertically to the horizontal for 50F cooling and returning along a directrix to read the film coefficient as 161 Btu per hour per square foot per F. Entering Table 5 at this value of h, move horizontally over to the r_i column for 3 in. pipe and interpolate to find .0106 as the inside film resistance per lineal foot of pipe.

The base value of the outside film coefficient (for flow normal to a single pipe) is determined from Fig. 12 as 157 Btu per hour per square foot per F. The procedure for obtaining this value is shown by the dashed line on the figure and it will be noted that for the special case of Freon-11 the temperature of the fluid (in the range from 0F to 100F) does not influence the value of the film coefficient.

For flow normal to a bundle of staggered tubes the base value of h_o can be increased by 30% (as discussed in the article); hence, for this problem the corrected value of the outside coefficient is $1.3 \times 157 = 204$. Entering Table 5 at this value and moving over to the column for r_o under 3 in. pipe interpolate to obtain .00361 as the outside film resistance per lineal foot. From the same table the wall resistance of 3 in. extra-heavy wrought-iron pipe is read as .000856. The total fluid-to-fluid resistance for the staggered tube exchanger is then $R = .0106 + .000856 + .00361 = .0151$ and the rate of heat transfer per lineal foot of tube is $(t_h - t_c)/R = (50 - 35)/.0151 = 993$ Btu per hour.

For the in-line exchanger the chart h_o can be used directly; hence from Table 5 for $h = 157$ find $r_o = .0044$. Then $R = .0106 + .000856 + .0044 = .01586$ and the rate of heat transfer per lineal foot of tube is $(50 - 35)/.01586 = 945$ Btu per hr.

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†Similar articles on water, ammonia, sulfur dioxide, brine and Freon-12 appeared in the December, 1944 and January to April, 1945, incl., issues of HEATING AND VENTILATING.

**Professor of Mechanical Engineering and Chairman, Division of Mechanical Engineering, University of California, Berkeley.

***Associate Professor of Mechanical Engineering, University of California, Berkeley.

NOTE: Freon is a copyrighted trade name held by the Kinetic Chemicals Company.

TABLE 5.—THERMAL RESISTANCES PER LINEAL FOOT OF EXTRA HEAVY IRON OR STEEL PIPE

(r_i = Inside film resistance; r_p = pipe wall resistance; r_o = outside film resistance; h = film coefficient of heat transfer from charts)

Material	Nominal Diameter, Inches																			
	¼		½		¾		1		1½		2		2½		3		3½		4	
	Values of r_p																			
St.[1]	.00346		.00260		.00210		.00193		.00144		.00124		.00129		.00114		.00105		.000992	
W.I.[2]	.00258		.00194		.00157		.00145		.00108		.000925		.000964		.000856		.000787		.000740	
h	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o
50	.253	.141	.140	.0909	.103	.0727	.0798	.0581	.0509	.0402	.0394	.0322	.0328	.0266	.0263	.0218	.0227	.0191	.0200	.00170
100	.126	.0707	.0700	.0455	.0515	.0364	.0399	.0290	.0255	.0201	.0197	.0161	.0164	.0133	.0132	.0109	.0113	.00954	.00998	.00848
200	.0631	.0354	.0350	.0227	.0258	.0182	.0200	.0145	.0127	.0101	.00985	.00804	.00821	.00664	.00657	.00545	.00567	.00477	.00499	.00424
300	.0421	.0236	.0233	.0151	.0172	.0121	.0133	.00968	.00839	.00670	.00657	.00536	.00548	.00442	.00438	.00364	.00378	.00316	.00333	.00283
400	.0316	.0177	.0175	.0113	.0124	.00909	.00997	.00726	.00636	.00503	.00493	.00402	.00410	.00332	.00329	.00278	.00284	.00238	.00250	.00212
500	.0253	.0141	.0140	.00909	.0103	.00727	.00798	.00580	.00509	.00402	.00394	.00322	.00328	.00266	.00263	.00218	.00227	.00191	.00200	.00170
600	.0210	.0118	.0117	.00757	.00858	.00606	.00665	.00484	.00424	.00337	.00328	.00268	.00274	.00221	.00219	.00182	.00189	.00159	.00166	.00141
700	.0180	.0101	.0100	.00649	.00736	.00519	.00570	.00415	.00363	.00287	.00281	.00230	.00235	.00190	.00188	.00156	.00162	.00136	.00143	.00121
800	.0158	.00888	.00875	.00568	.00644	.00454	.00499	.00363	.00318	.00251	.00246	.00201	.00205	.00166	.00164	.00136	.00142	.00119	.00125	.00106
900	.0140	.00785	.00778	.00505	.00572	.00404	.00444	.00323	.00283	.00223	.00219	.00179	.00182	.00147	.00146	.00121	.00126	.00106	.00111	.000942
1000	.0126	.00707	.00700	.00455	.00515	.00364	.00399	.00290	.00253	.00201	.00197	.00161	.00164	.00133	.00132	.00109	.00113	.000954	.000998	.000848
1100	.0115	.00643	.00636	.00413	.00478	.00330	.00363	.00264	.00231	.00183	.00179	.00146	.00149	.00121	.00119	.000993	.00103	.000866	.000907	.000770
1200	.0105	.00589	.00583	.00378	.00429	.00303	.00332	.00242	.00212	.00168	.00164	.00134	.00137	.00111	.00109	.000910	.000945	.000795	.000831	.000706
1300	.00972	.00544	.00538	.00349	.00396	.00280	.00307	.00223	.00196	.00155	.00152	.00124	.00126	.00102	.00101	.000840	.000873	.000733	.000767	.000652
1400	.00903	.00505	.00500	.00324	.00367	.00260	.00285	.00207	.00182	.00144	.00141	.00115	.00117	.000949	.000940	.000780	.000810	.000681	.000712	.000605
1500	.00842	.00471	.00467	.00303	.00343	.00242	.00266	.00194	.00169	.00134	.00131	.00107	.00109	.000885	.000876	.000728	.000756	.000635	.000665	.000565
1600	.00790	.00442	.00437	.00284	.00321	.00227	.00249	.00181	.00159	.00126	.00123	.00100	.00103	.000830	.000821	.000682	.000709	.000595	.000624	.000530
1700	.00743	.00416	.00412	.00267	.00302	.00214	.00234	.00171	.00150	.00118	.00116	.000946	.000966	.000781	.000774	.000642	.000667	.000560	.000587	.000498
1800	.00702	.00393	.00389	.00252	.00286	.00202	.00221	.00161	.00141	.00112	.00109	.000894	.000913	.000737	.000730	.000606	.000630	.000530	.000554	.000471
1900	.00665	.00372	.00368	.00239	.00271	.00191	.00210	.00153	.00134	.00106	.00104	.000846	.000865	.000699	.000692	.000575	.000596	.000502	.000525	.000446
2000	.00631	.00354	.00350	.00227	.00258	.00182	.00200	.00145	.00127	.00101	.000985	.000804	.000821	.000664	.000657	.000545	.000567	.000477	.000499	.000424

[1]Mild Steel. [2]Wrought Iron.

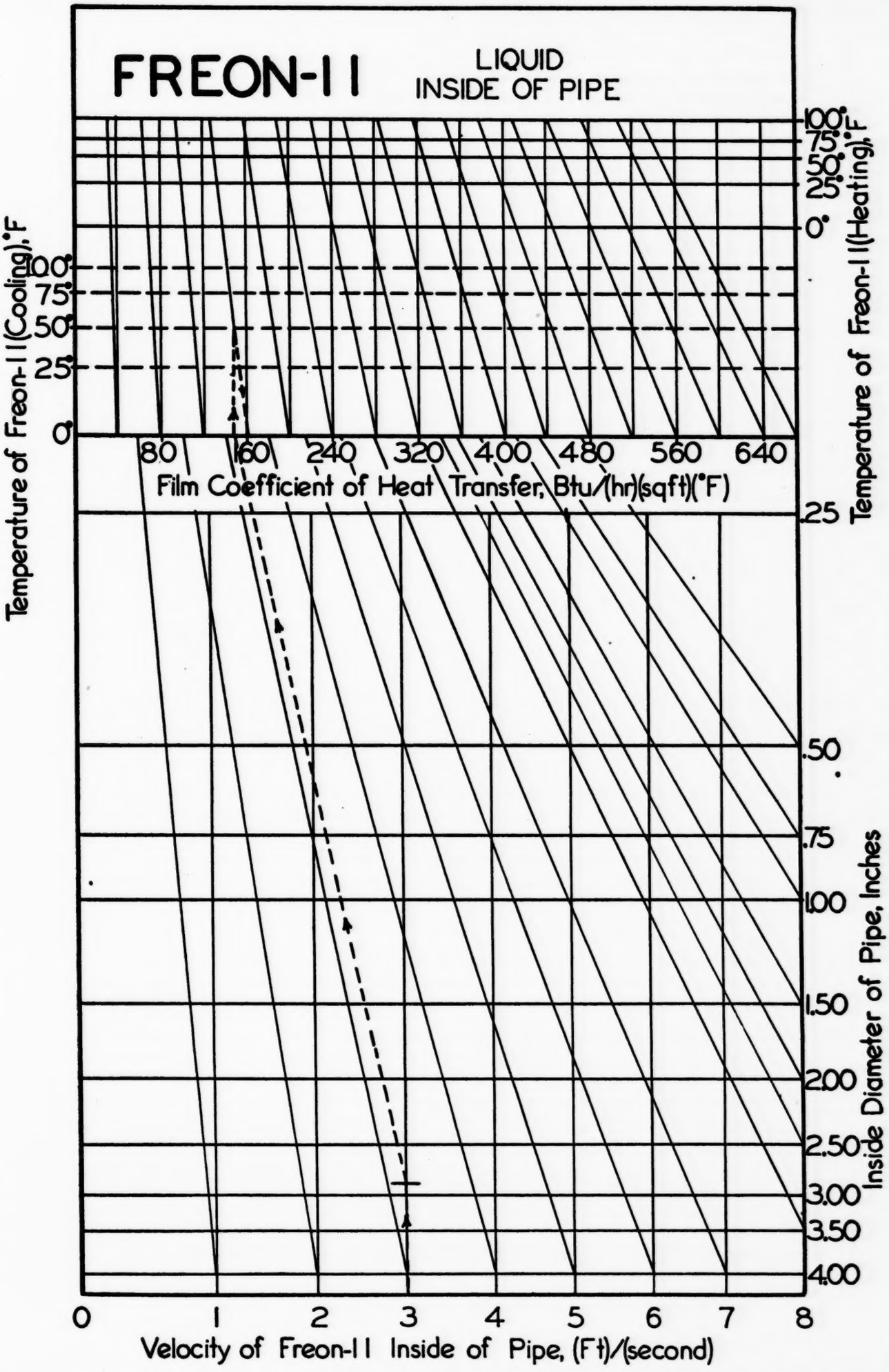

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Fig. 11. Film coefficient for liquid Freon-11 flowing inside a pipe.

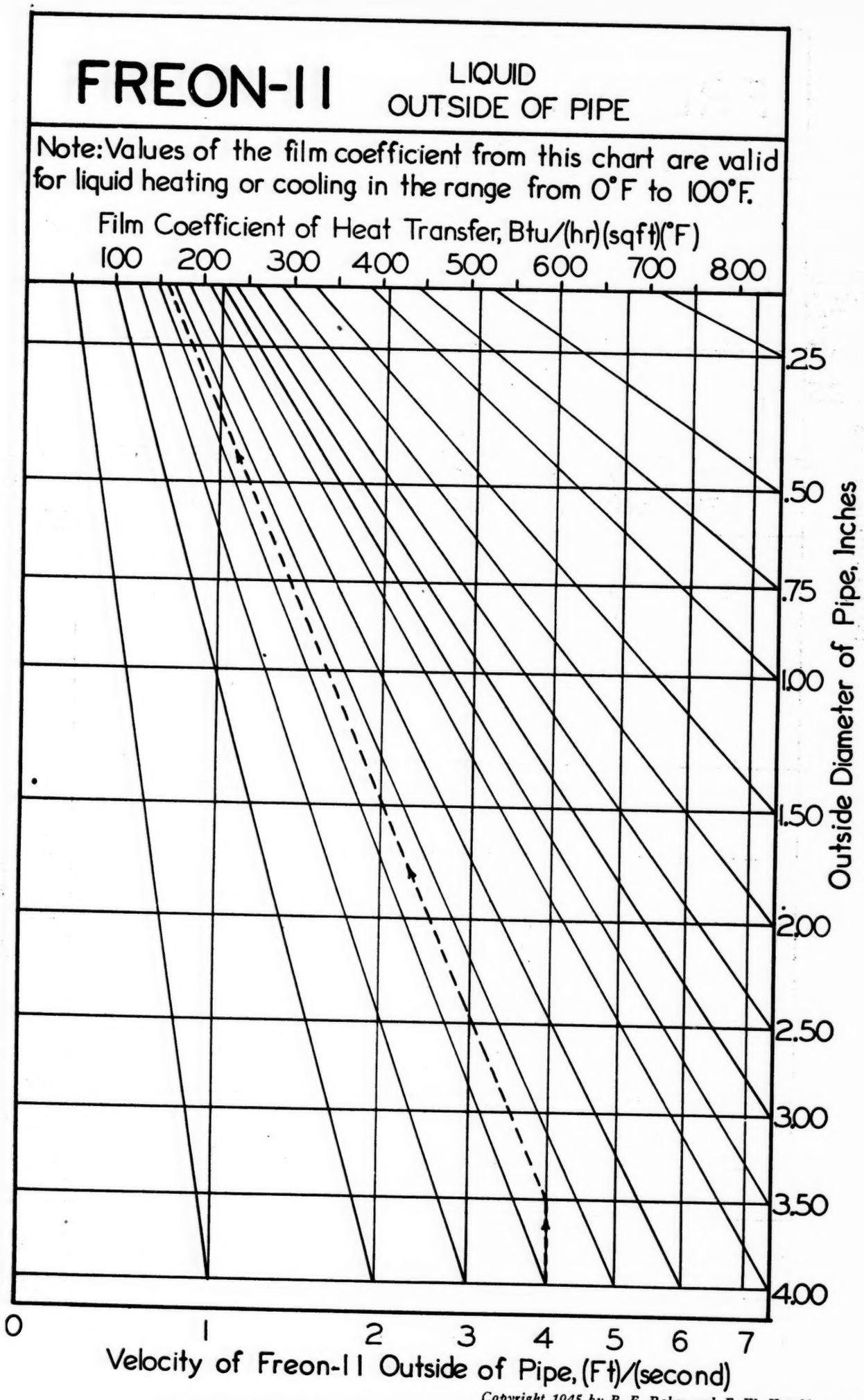

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Fig. 12. Film coefficient for liquid Freon-11 flowing outside a pipe.

In Prime Condition

By JOHN J. WOOLFENDEN

Engineering Staff, Smith, Hinchman & Grylls, Inc., Architects and Engineers, Detroit, Mich.

THE system, itself, consisted of nine fan units, of which four were supply units, the remainder being exhaust fans, and several hundred square feet of direct radiation, all located above the first floor. Steam was supplied by a firebox type H.R.T. boiler, 72 in. x 19 ft 2 in., operating at low pressure and installed in the boiler room well below the general basement level. Condensate was returned to the boiler by a vacuum pump. The boiler was fitted with a dry-pipe and was stoker fired.

The steam outlet of the boiler was connected to a 12 in. header, the elevation of which was below that of the boiler water line, some 24 in. This header was dripped, through a trap, to the return system.

From the header, two 8-in. mains were run, one to supply the west side of the building and one to supply the east side. These ran for some 25 ft on the east side and 60 ft on the west side, each terminating in an upfeed riser to a steam main in the upper part of the building.

When the system was put into operation under full load conditions—especially during the first hour or two of operation—an unusually severe water hammer developed, which continued unabated for from one to two hours. The shocks were so severe that it was felt that there was danger of breaking a fitting on the lines. This hammer was confined to the west branch of the main.

Meantime, observation of the other conditions disclosed no indications of distress. The water line of the boiler was remarkably steady, there being only a leisurely, slight rise and fall, or "breathing," such as might be noted in the case of any boiler operating under load.

In order to further ascertain the underlying conditions, the drip and trap were disconnected from the header and a 1¼ in. valved, open end, bleeder pipe installed in their place. This pipe, with the valve gradually opened full, ran a continuous, solid stream of water. Still the water line was perfectly steady.

As a further paradox, it was found that, when steam pressure was raised on the boiler from a "cold" condition to operating pressure, as quickly as possible—that is, in about half an hour—conditions were apparently perfectly normal. On the other hand, if the pressure was brought up at a slower rate, say, in about 2 hours, the water hammer invariably was present. In making these tests, the valves were left open and the whole system brought up to pressure with the boiler. These results were exactly the opposite of what might be expected.

Had it not been for the fact that the water line remained so steady throughout, it would have been natural and logical to conclude that the boiler was foaming or priming; but each time this theory was advanced, it was discarded on the evidence of the behaviour of the water line.

The setting of the gauge glass was questioned, but assurance was given that proper levels had been taken from the top row of tubes and the height of the glass was correct.

As soon as the boiler could be shut down for a reasonable period, an examination was made and the gauge glass level and boiler pitch checked with a hydraulic level.

It was then found that, with the top row of tubes properly submerged, the height, from the water surface to the highest part of the shell, inside, was a trifle over 10 inches and that the gauge glass was actually set several inches too high, so that at what would be considered, by the gauge, as normal water level, raised the water so high as not only to restrict the steam space, but to tend to flood the dry pipe. This, coupled with the resulting diminution of steam liberating surface and high steam velocity, gave the remaining answers to the questions excepting one—"Why did the water line in the gauge remain so uniformly steady when the boiler was throwing water out literally by the barrelful?"

To that question, the writer can think of only one logical answer: that the conditions inside the boiler were so stabilized that there was no surging. That is, that the feed water was being returned at such a uniform rate that, with the steady load, the steam liberation and steam velocity were practically constant; that any "piling up" of the water at the dry-pipe was also constant.

As to why the water hammer ceased, after an hour or two, the probability is that, after the building became thoroughly warm, the steam requirement became less and the steam velocity and hence the priming decreased as the load lightened and conditions stabilized.

A word or two regarding the hydrostatic level used may be of interest. It was a home-made affair, extemporized for the occasion out of two battery hydrometer glasses and 25 ft of ¼ in. rubber tubing; all purchased at the local five and ten. The glasses were inserted in the ends of the tubing and the joint well wrapped with friction tape—also from the five and ten. The whole thing cost less than a dollar and about 15 minutes' time to fix the glasses in place and fill the level with water. In filling this device, care was taken to eliminate air bubbles by raising one end as high as possible and pouring the water into the other end, which was kept low at the start and raised, gradually, to the level of the higher end as the water was poured slowly in, but always with the top just above water level. When equality of height was attained, a mark upon each glass was made to indicate the water line at level position.

New Developments in Washington

Limitation and Conservation Orders Are Being Rapidly Revoked; WPB Speeds Change to Normal

LORING F. OVERMAN

WITH the War Production Board making good its promise to revoke many of its L and M (Limitation and Conservation) Orders as quickly as possible after VE-Day, those planning the post-war course of the heating, ventilating and air-conditioning industry will find plenty of food for thought in what has been done and in what must yet be accomplished.

Between VE-Day and May 22, WPB had revoked 70 L and M Orders—13 of them either directly or indirectly affecting the industries served by this publication. Following is the list:

- L-22 Established simplified practices in the manufacture of furnaces.
- L-38 Establishing production quotas and delivery restrictions for 28 types of industrial and commercial refrigerating and air conditioning machinery and equipment.
- L-74 Governing production and distribution of domestic type oil burners.
- L-75 Coal stokers with grate area of 36 square feet or less.
- L-107 Extended surface heating equipment.
- L-126 Drinking water coolers; coil and tube assemblies for refrigeration condensers or coolers; service connections.
- L-173 Floor and wall furnaces.
- L-187 Cast iron boilers.
- L-221 Electric motors and generators.
- L-250 Electric motor controllers.
- M-126 Controlling use of iron and steel in specified products.
- M-9-c Controlling use of copper in specified products.
- U-1 Direction 1—delivery restrictions on transformers.

What Revocations Mean

For the moment, revocation of the foregoing orders means that specific restrictions included in the orders are no longer in effect. For example, Order L-38, by denying quotas of metal to some manufacturers, effectively prevented the manufacture of 19 types of air conditioning and refrigerating equipment. Most of them were small units in the food refrigeration and servicing fields, but included were self-contained air-conditioning units of room size and of store size under 3 horsepower. Of the types for which some civilian manufacture was permitted, rigid quotas were established—25% of a base period for both high and low side equipment of all types. Priority ratings controlled distribution.

Revocation of the Order means that those with zero quotas, as well as those with specified production quotas, may resume manufacture without technical restriction as outlined in Order L-38. Factually, however, they may start manufacture only if they can find materials.

Metals Sources Controlled

The basic shapes of steel, copper and aluminum remain under the control of CMP, the Controlled Materials Plan—subject to allocation to designated receivers for specific purposes by the War Production Board. Thus the current revocation of L and M Orders may be regarded somewhat as an opening of the bathroom faucets before pressure has built up in the mains. Even this process, however, clears the air out of the pipes and is the forerunner of a coming flow—at first spotty, and later a steady stream.

Revocation of L and M Orders affecting the heating, ventilating and air-conditioning industries should be regarded as an encouraging sign, one that permits immediate planning for limited production at an early date; perhaps capacity operation as soon as the metals demands of the Pacific War have been clarified.

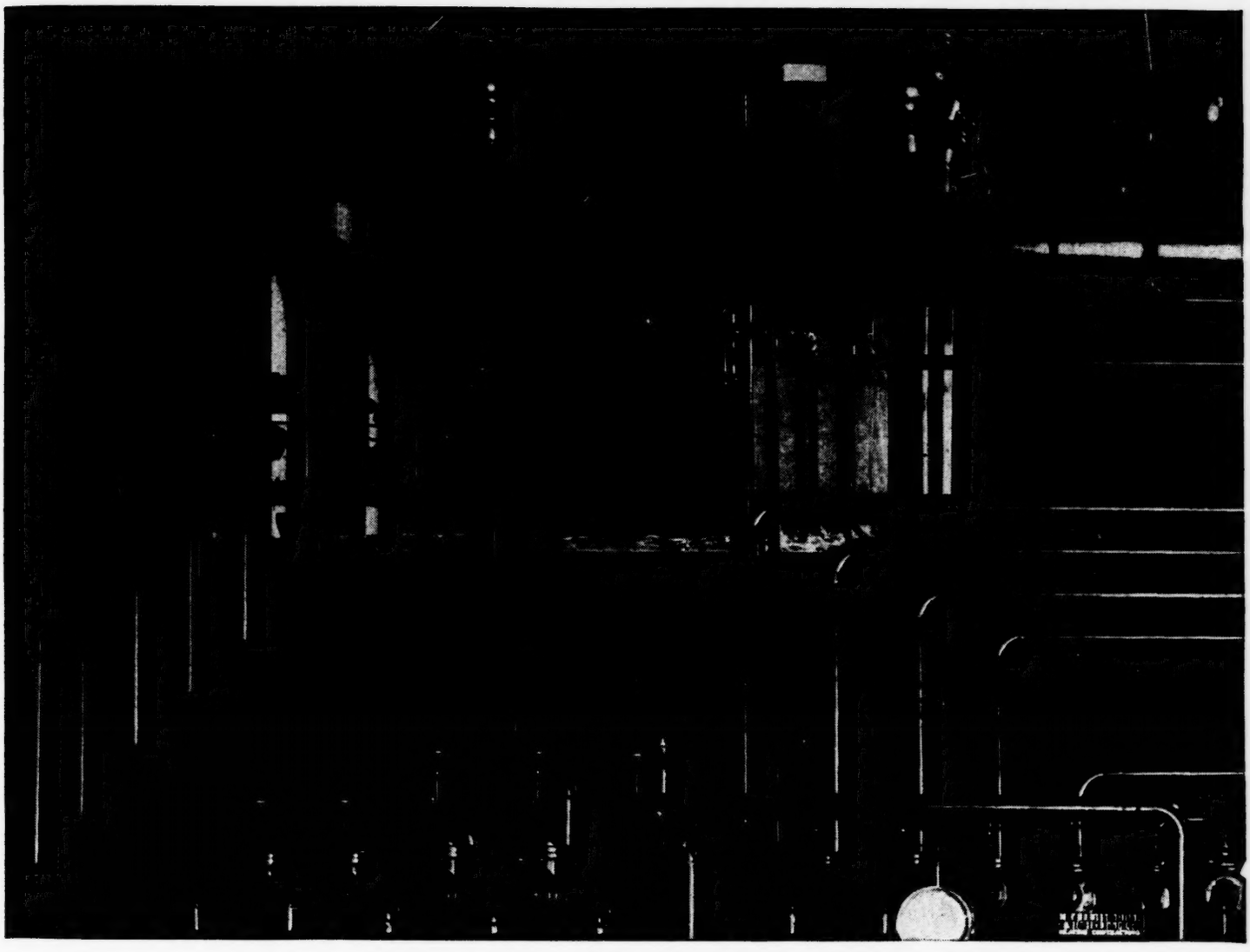
War Contracts Continue

To the fact that raw materials will continue to be controlled at the source must be added the fact that

WPB RECONVERSION ESTIMATE FOR THE HEATING, VENTILATING AND AIR CONDITIONING INDUSTRIES

Equipment Group	New Construction Required		Tools and Equipment Required		Conversion Time Required (Months)	
	For Minimum or Break-Even Rate	For "All-Out" or Capacity Rate	For Minimum or Break-Even Rate	For "All-Out" or Capacity Rate	For Minimum or Break-Even Rate	For "All-Out" or Capacity Rate
Commercial and Industrial Refrigeration and Air Conditioning Equipment	0	$7,000,000	0	$3,000,000	3	9
Cast Iron Boilers	—	—	—	100,000	0	3
Cast Iron Radiators	—	—	0	100,000	0	3
Extended Surface Heating Equipment	—	—	100	100,000	0	0
Gas Conversion and Industrial Gas Burners	—	—	0	0	0	2
Heating Controls and Heating Specialties	0	30,000	0	125,000	0	3
High Pressure Steel Boilers	—	—	0	250,000	0	0
Low Pressure Steel Boilers	0	300,000	0	50,000	0	3
Indirect Water Heaters	—	—	0	0	0	0
Mechanical Stokers	—	—	0	0	0	2
Oil Burners	—	—	180,000	300,000	2	3
Warm Air Distribution Equipment	0	1,000,000	0	250,000	0	0
Warm Air Furnaces	0	250,000	0	250,000	0	1

Note. (—) Indicates no estimate given.



The fittings that snuggle up

IT makes a lot of difference, when you're laying out a piping system, whether you use Tube-Turn welding fittings that snuggle up to each other going around corners—or other type fittings that demand a world of "elbow room." Lines can be placed nearer to ceilings and walls and nested closer in smaller tunnels.

Other important advantages of Tube-Turn welding fittings include lighter weight, greater strength, and longer life. Their streamlined design permits easier insulation, and the fact that they are permanently leak-proof means that insulation will not have to be replaced. Smooth turns insure maximum efficiency of flow.

Specify Tube-Turn welding fittings for your next piping job, and gain all these money-saving benefits!

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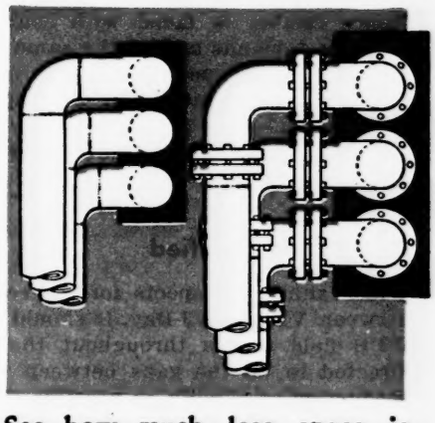


See how much less space is required for compound turns made with Tube-Turn elbows!

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*

many producers of heating, ventilating and air-conditioning equipment are still busy with war work. The subject of the probable lag between the time war contracts are terminated and "break-even" and "all-out" production, has been under study by the War Production Board. Seventy-two industries were studied, including those with which this column is concerned. In the accompanying table are shown the conclusions with regard to contemplated peacetime production, new construction required, value of equipment and tools required, and the length of time estimated for partial and complete conversion.

A study of the table reveals that the changeover from wartime to civilian production can be made with a minimum expenditure for new equipment, and that in most instances the time lag will not be great. In contrast, some industries face vast expenditures before a wheel can turn on a civilian item, with important time lags intervening. The automotive industry estimates eight months will be required to reach the break-even point, and 15 to reach capacity; sewing machines, 6 and 9, respectively; domestic electric ranges, 5 and 9; clocks and watches, 7 and 7; flat silverware, 12 and 12, and pianos, 7 and 7.

•

Construction Total High

Of interest to those thinking in terms of probable need for industrial air-conditioning and refrigeration, the WPB reconversion survey contains the interesting estimate that a total of $234,664,000 in new construction will be required by the 72 industries studied, before all-out production is reached. Again, however, the continued short supply of certain materials may constitute a bottleneck to construction activities.

Lumber promises to be the limiting factor of the reconversion construction program, both industrial and commercial, and the War Production Board is acting to relieve the situation.

"Construction activity is to some extent the keystone of the partial reconversion made possible by VE-Day," observed J. Philip Boyd, director of the WPB Lumber and Lumber Products Bureau. "Proposed third quarter allocations and reserves for civilian use total 1,546,115,000 board feet, a 13% increase over those of the second quarter. Decline in military demand for lumber will be felt at a later date than for many other war materials. Hence lumber is faced with continued pressure from military demands and at the same time with increasing pressure from expanding civilian needs."

Importance of increasing the supply is recognized by WPB as necessary to a successful reconversion program, and efforts are being made to provide the manpower and equipment needed.

Order L-41 Modified

In scanning prospects for the semi-conversion period between VE and VJ-Day, it should be remembered that WPB field offices throughout the country have been directed to fill the gaps between wartime and civilian production as rapidly as possible. Typical is the recent relaxation of the Construction Order (L-41) to permit Field Offices to approve minor construction necessary to initiate or resume civilian production. Although no change was made in the present low limits of dollar value of construction that may be started without WPB approval, a Direction to the Order gives Field Officials far more leeway than in the past in granting applications for additions to or changes in plants or projects related to reconversion. While construction of plants entirely new must pass rigid WPB tests, there are indications that a goodly number of applications will be approved unless an unusually tight labor situation interferes.

Thus many an air-conditioning project that was filed away for the duration can now be dusted off with considerable assurance that it will not be a waste of time to bring it up to date and present it to a prospect for reconsideration. Although it may not, in all cases, prove possible to secure an approval, the rules are becoming more flexible each day. This trend will continue as cutbacks in military orders continue and as manpower becomes available.

Surface Heating Group Divided

That revocation of some of WPB's orders may not meet with the entire approval of industry is indicated by the fact that opinion of members of the Lightweight Extended Surface Heating Equipment Industry Advisory Committee was divided as to the advisability of revoking Order L-107, controlling such products. Some committee members and Government officials present at the May meeting in Washington held that removal of the rating pattern through revocation of the order would deplete stocks and endanger the supply for military and essential civilian use next fall.

Consensus favored revocation however, and the action was announced on May 22. Items affected by the revocation are unit heaters, unit ventilators, copper convectors and blast heating coils. The limitation order, as originally issued June 13, 1942, prohibited delivery of the equipment except to the armed services and upon specific authorization. A simplified practice schedule appended to the order was revoked November 16, 1944, and the order was later amended to limit delivery to approved orders bearing preference ratings of AA-5 or better.

Production of the heaters during the first quarter of 1945 amounted to 35,800 heaters as compared with 45,000 in the fourth quarter of 1944, the 25% decline being reported as due to scarcity of motors and some necessary materials.

Approved Programs Outlined

Allotments of controlled materials to non-military claimant agencies for the third quarter of 1945 carry with them no advance authority greater than that already outstanding for the fourth quarter, it was announced on May 22 by WPB. This was explained to mean that while the controlled materials authorizations already issued for deliveries in the fourth and subsequent quarters will not be withdrawn, WPB will not issue additional "tickets" to non-military claimant agencies for delivery after September 30, 1945, except in unusual circumstances.

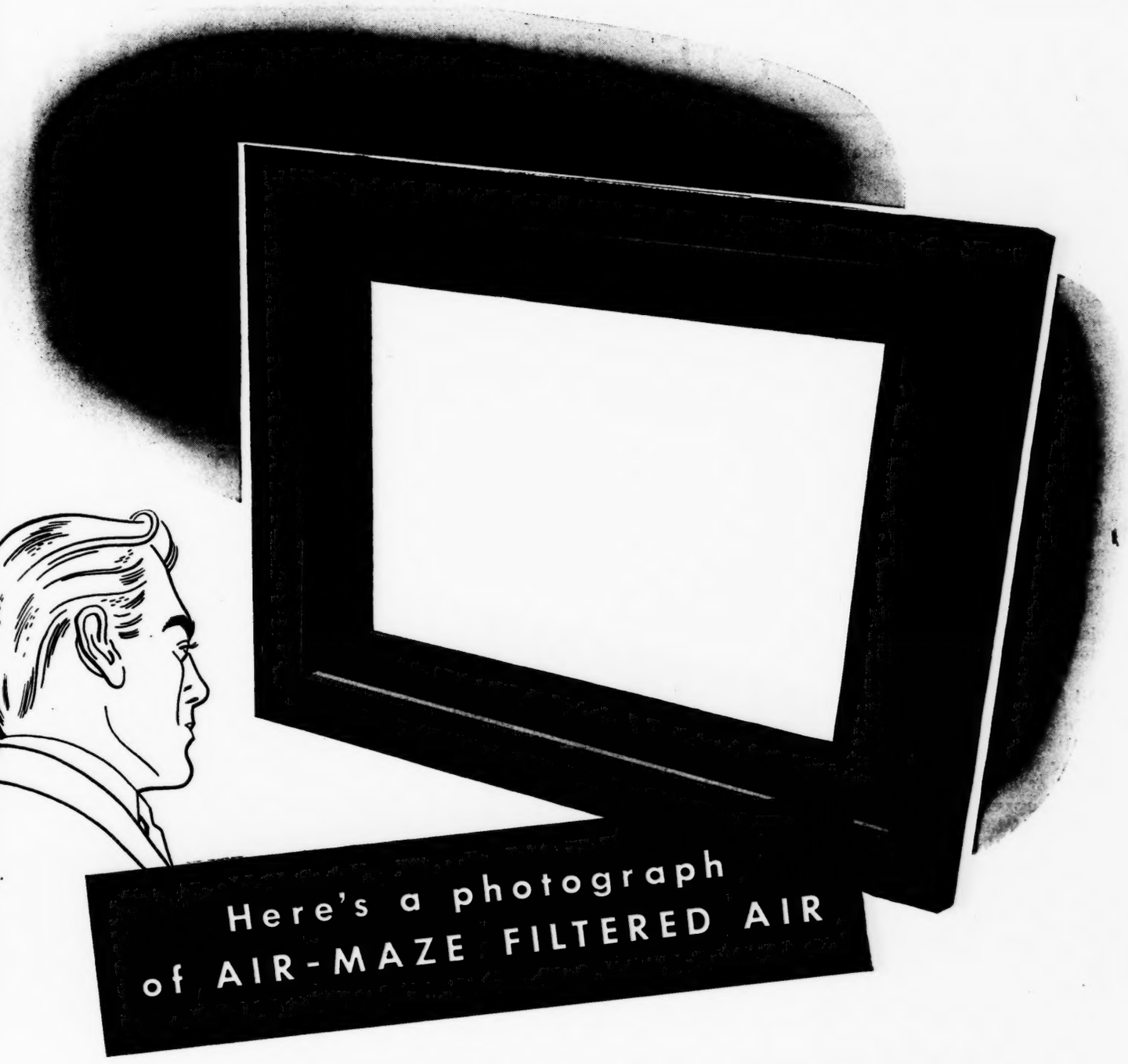
The reason for this action is that WPB hopes to put as much fourth quarter production as possible on an unrated basis (through its new CMP open-ending plan) and is therefore keeping fourth quarter commitments to a minimum.

Back to "Normal"

This policy is entirely in line with industry's repeated requests for a return to normal methods of purchase at the earliest possible moment, and it will be interesting to observe the operation of a plan that seeks to grant this wish to those not continuing in war production, while at the same time protecting the materials requirements of those still producing for the Pacific War and for the civilian programs regarded as "musts".

WPB is betting on the hunch that the war-boosted production of basic materials will be sufficient to supply this half-directed, half-freed economy with plenty to spare. Chief cause for concern is the fact that while some materials and components may be surplus, others will constitute bottlenecks.

As frequently suggested in this column, the unwinding of wartime restrictions may prove more baffling than the winding—a challenge to private industry and individual thinking.



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NEWS OF THE MONTH

REMA Inaugurates Educational Program

CHICAGO — To foster the interests of the entire refrigeration and air conditioning industry during the reconversion and post-war periods, a public and trade education program was launched on May 1 by the Refrigeration Equipment Manufacturers Association.

In announcing the program, R. Kennedy Hanson, Pittsburgh, executive secretary of REMA, revealed that it is being planned to help meet the needs of end-products manufacturers, as well as parts producers, distributors, dealers, engineers and servicemen. Under the direction of Theodore R. Sills, whose public relations firm will conduct the campaign, activities will emphasize the need for maintaining existing equipment during the period when demand will continue to exceed supply, while building up a maximum acceptability among prospective users to reach its climax at the time the industry will be ready for new markets.

All types of media—reaching the general public as well as many trades interested in refrigeration — will be employed to impress the many advantages of the industry's equipment. General public enthusiasm, Mr. Sills predicts, will gradually make itself felt among commercial prospects for new installations in restaurants, movie theaters, office buildings and schools.

Oil Heat Institute Meets

CHICAGO.—The 22nd annual meeting of the Oil-Heat Institute of America, Inc., was held in Chicago on May 8. Owing to ODT travel restrictions, only the officers and board of directors were present with membership voting by proxy on questions previously submitted by mail.

W. A. Matheson, president, Williams Oil-O-Matic Heating Corporation, Bloomington, Ill., was elected president of the institute succeeding C. E. Lewis of Perfex Corp., Milwaukee.

J. H. Van Sciver, president, Bethlehem Foundry and Machine Co., Bethlehem, Pa., was elected vice-president. W. A. Kemp, Sundstrand Machine Tool Co., Rockford, Ill., was reelected chairman of the accessory division. C. R. Jonswold, Triangle and Arrow Oil Companies, Chicago becomes chairman of the distribution division replacing F. E. Spencer of Chicago.

Sixteen members of the Board of Directors were re-elected. New members of the Board are—S. H. Shipley, York, Pa.; V. K. Smith, Cleveland, Ohio; J. W. Owens, Chicago; E. P. Hacker, Portland, Maine; J. C. Yeomans, Portland, Ore.; J. A. Collins, Buffalo; F. C. Haab, Philadelphia; J. W. Warner, Washington, D. C.; and C. R. Jonswold, Chicago.

A. E. Hess, Managing Director; C. F. Curtin, Secretary-Treasurer and G. T. Kaufman, Technical Secretary, were reappointed.

The next meeting of the Board of Directors was set for July 10, at New York City.

Sound Film on Arc Welding

CLEVELAND, OHIO—To permit an easy understanding of the real cause of distortion when welding, the Walt Disney Productions has prepared a motion picture in color with sound for the Lincoln Electric Co. Distortion is pictured as the animated character Mr. Shrink. He helps to portray the three simple rules that a welder must remember: Reduce the effective shrinking force; make shrinkage forces work to minimize distortion; balance shrinkage with other forces. The film, "Prevention and Control of Distortion in Arc Welding," has a running time of 20 minutes and is available at no cost except for transportation by writing to The Lincoln Electric Co., 12818 Coit Rd., Cleveland 1, Ohio.

Prof. Tuve Advanced

CLEVELAND.—Professor G. L. Tuve of Case School of Applied Science, Cleveland, Ohio, has just been appointed head of the Department of Mechanical Engineering to succeed Professor F. H. Vose, who has held the office for 31 years. Professor Tuve will start his new duties on July 1, after having served on the Case Faculty since 1930.

Professor Tuve has specialized in heating, ventilating, air conditioning, heat transmission and air flow since receiving his B.S. in Mechanical Engineering from the University of Minnesota in 1920; and his M.E. from the same institution in 1921. His industrial experience has been with the Public Service Company of Northern Illinois, the Allis Chalmers Manufacturing Company, the American Locomotive Company and others. He joined the staff of the University of Minnesota and then became Assistant Professor of Mechanical Engineering, University of Montana and later Professor and Head of the Department of Mechanical Engineering at Texas Technological College.

He is co-author with Professor C. F. Shoop of a text book, Mechanical Engineering Practice, which includes instruction for common test work encountered by heating and ventilating engineers. He has been a contributor to Marks' Handbook and other publications.

Phila. Gets Packaged Fuel

PHILADELPHIA—A new plant was opened here May 23 for the manufacture of a combined anthracite and bituminous packaged coal.

The plant is operated by Blaw-Knox Company. First large-scale production is being sponsored by Solid Fuels Administration.

The product consists of six three-inch cubes wrapped in orange paper, so clean that it may be handled with white gloves.

In processing the fuel, the anthracite and bituminous coal lumps are passed separately through a revolving cylindrical dryer. The remaining dust is then removed and the clean, dry coal is crushed to exact size required for final processing.

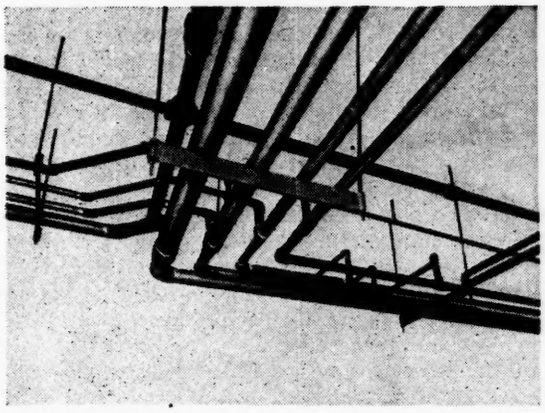
The coal is next blended in proper proportion to produce a slow, hot and practically smokeless fire. The blend is heated, mixed with a binder and given the final shape. The three-inch cubes are then cooled, wrapped, sealed and labeled at each end ready for the consumer.

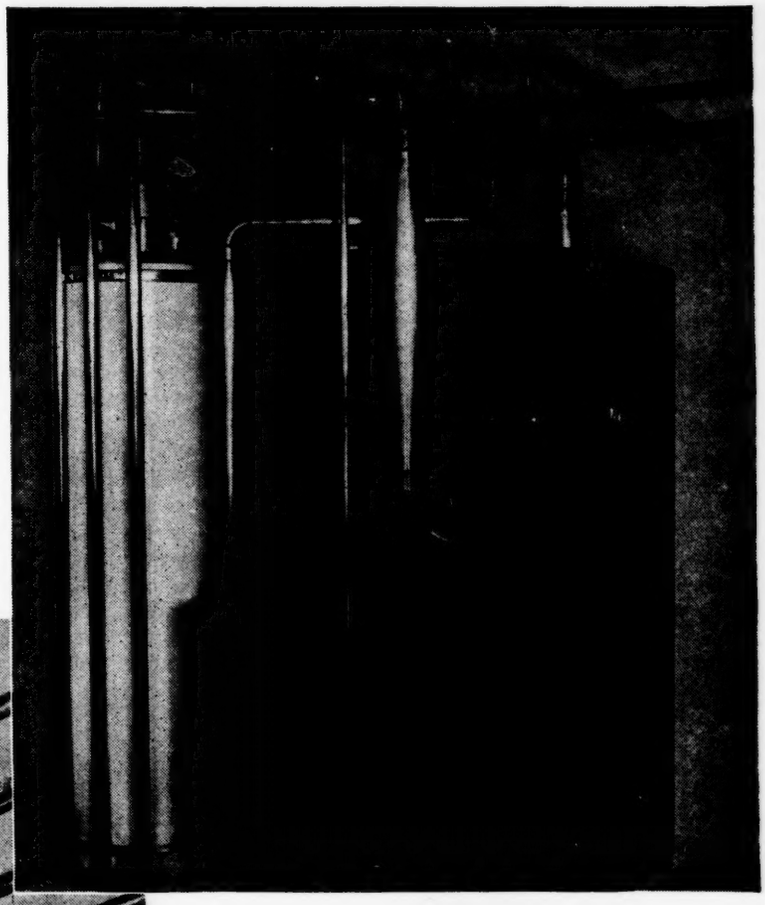
Buffalo Group Elects Moesel

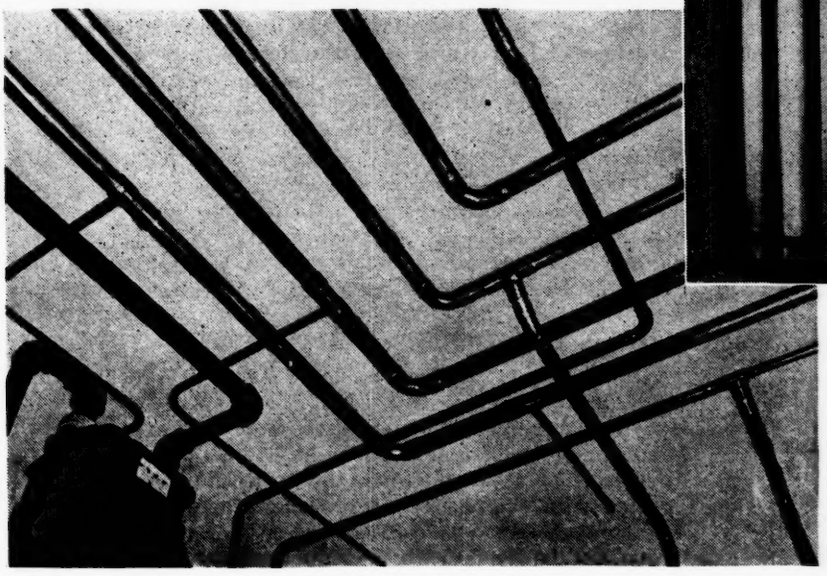
BUFFALO—The Western New York Chapter of the American Society of Heating and Ventilating Engineers at a recent meeting elected the following officers for the 1945-1946 season: president, F. Albert Moesel; first vice-president, H. Seelbach, Jr.; second vice-president, George Adema; treasurer, B. C. Candee; secretary, John S. Meyer. Elected to serve on the board of governors are: Myron C. Beman, Joseph Davis, W. R. Heath, and Ross Farnam.

Lawlor Addresses ASRE

HARTFORD—M. M. Lawlor, manager of Air Conditioning and Refrigeration Division of Worthington Pump & Machinery Corp., spoke on "Centrifugal Refrigeration," at the May meeting of the Connecticut Valley section of the American Society of Refrigerating Engineers. His paper covered the theory, design and application of centrifugal compressors which he said are best applied in ranges from 75 to 1200 tons.







COPPER stays young

A BUILDING, like a man, can suffer from faulty circulation. But in the case of a building, the trouble comes less from age than it does from the kind of materials used in its water and heating lines. To keep such installations sound and youthful, the material to use is copper, which stays young. By specifying or installing Revere Copper Tube, you can protect the owner's financial investment and guard users against serious trouble.

Revere Copper Tube (99.9% pure copper) is seamless and is cold drawn with a gun-barrel finish inside. It is deoxidized and is free from flaws and blemishes. Joints are made with either soldered or compression fittings.

Designed for water supply, heating, air conditioning and other services in all types of buildings, this tube is stamped with the Revere name and type at regular intervals. Look for these identification marks—they insure full wall thickness and the close gauge tolerances so essential for tight sweated joints.

In making your post-war plans, you can specify or use such long-lived Revere materials as copper tube and pipe; Red-Brass pipe; sheet copper for tanks, ducts, pans and trays; sheet Herculoy for tanks; Dryseal copper refrigeration tube (dehydrated and sealed); copper oil burner, heat control and capillary tubes.

Revere materials are handled by Revere Distributors in all parts of the country. The Revere Technical Advisory Service, Architectural, is always ready to serve you. Call Revere.

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New Heating Labs for S. C. Gas Co.

LOS ANGELES—The Southern California Gas Co., Los Angeles, has placed in operation a newly built and equipped gas measurement laboratory which is said to rank among the most advanced in the country for testing and measuring the heating value of gas. To house the laboratory, the company erected a new one-story, fireproof structure adjacent to its engineering building in which 3,000 sq. ft. of floor area are available for a variety of devices designed for heat-value testing and measuring, and auxiliary purposes.

The laboratory is equipped for a two-fold function: first to make tests, by means of automatic and water flow type calorimeters of the heating value of the gas supply of the utility company; second, to check on the specific gravity of the gas supply, a process necessary in order to obtain a record required as one of the factors of meter coefficients in orifice measurement.

The instrument room is completely air conditioned with a Servel gas-fueled, all-year air conditioning system. This is necessary, the company pointed out, because the testing work must be carried out under constant temperature or humidity conditions.

In collaboration with the Southern Counties Gas Co. of Los Angeles, the Southern California Gas Co. (both of which are subsidiaries of Pacific Lighting Corp.) in March also opened up a new gas appliance testing laboratory. This new department is located on the third floor of the engineering building. The appliance laboratory is equipped to make tests on gas water heaters and gas floor- or wall-mounted or portable heaters, as well as on all other types of gas appliances. The appliance laboratory was set up to assist and cooperate with heater, water heater and appliance manufacturers in matters beyond the scope of the American Gas Association testing laboratory in Los Angeles.

While plans to that effect are at present in deferment due to the war and equipment shortage, the Southern California Gas Co. and Southern Counties Gas Co. contemplate, as soon as conditions make it feasible, to erect a gas heating research house on Sante Fe Avenue in close proximity to the new appliance testing and gas measurement laboratories. A desire to group all testing facilities at the same general location prompted the companies in March to abandon a well-equipped gas heating research house which the two firms had operated jointly at the Macy Street gas plant for the past four years.

Equipment from the discontinued research house has been stored in the new appliance laboratory until a new test house can be erected. Equipment already available and ready for installation when the house is built include devices for recording temperature, air resistance, air velocity, the rate of air entrance into a house through cracks at doors and windows, and other phases of heat measurement. Moved over also from the abandoned research house were instruments for observing temperature of different rooms in the same house; on temperature distribution; determining the speed of room heating; how much gas is required to heat a house of given size and construction type, and individual rooms therein, at various temperature differentials between outside and inside; and equipment to measure air infiltration into rooms.

Industrial Ventilation

In the report on the American Society of Heating and Ventilating Engineers meeting on industrial ventilation, which appeared on page 103 of the April issue, it was stated that the problem for discussion at the meeting concerned, among others, "where desirable toxic conditions exist." This should have read "where undesirable or toxic conditions exist."

Asbestos Textile Institute Formed

PHILADELPHIA, PA.—Recent discussions by a number of asbestos textile manufacturers have led to the formation of the Asbestos Textile Institute, with offices in 12 So. 12th Street, Philadelphia 7, Pa. It is a voluntary, non-profit, unincorporated organization to render service to manufacturers, to the trade, and to users of asbestos textiles. Membership in the institute is open to all individuals, corporations or others located in the United States who manufacture textiles from raw asbestos fibres.

The following companies, who represent a major portion of the asbestos textile production capacity in this country, became members: Asbestos Textile Company, J. Franklin Burke & Co., Carolina Asbestos Co., Garlock Packing Co., Johns-Manville Corp., Keasbey & Mattison Co., Philadelphia Asbestos Co., Raybestos-Manhattan, Inc., Southern Asbestos Co., and Union Asbestos & Rubber Co.

Activities contemplated by the Asbestos Textile Institute are the establishment of uniformly high standards of quality, research to develop new uses and new markets for asbestos textiles, and the preparation and distribution of technical and general information that will be of interest and value to engineers, designers, distributors, manufacturers and the general public.

Officers of the institute are: C. H. Carlough of Carolina Asbestos Co., president; George Marshall, Jr., Raybestos-Manhattan, Inc., vice-president; William C. Scott, Keasbey-Mattison Co., treasurer, and Harris D. McKinney, the Institute Manager and Secretary.

Instrument Society Formed

PITTSBURGH.—The Instrument Society of America was organized at a meeting held in Pittsburgh, Pa., on April 28 attended by delegates from 15 measurement and control instrument societies. The purpose of this new society is to advance the arts and sciences connected with the theory, design, manufacture and use of instruments. Pro-tem officers are A. F. Sperry, Chicago, president; C. F. Kayan, New York, vice-president; C. E. Fry, Pittsburgh, treasurer, and Richard Rimbach, secretary. Temporary office of the society is that of the secretary, 1117 Wolfendale St., Pittsburgh 12, Pa.

Central Heating Plan Approved

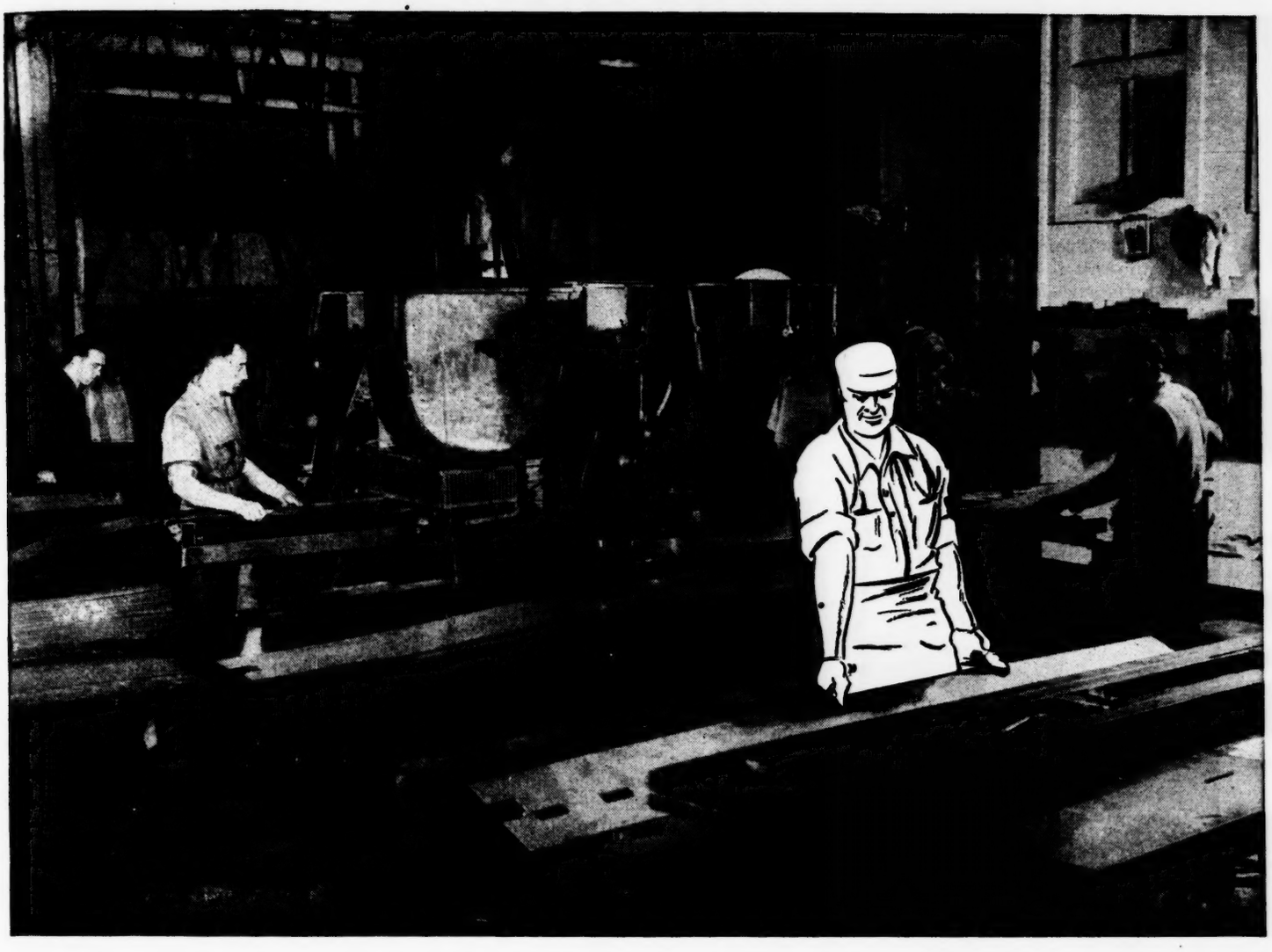
CHISHOLM, MINN. — The Chisholm City Council has passed an ordnance granting a franchise for furnishing steam heat to the entire city from a cooperatively owned plant. The franchise, awarded to John J. Dwyer of Duluth, authorizes the construction of an adequate steam and electric generating plant with the necessary underground heat distribution lines and electrical circuits, just as soon as war permits.

W. A. Russell

KANSAS CITY—After an illness of several months, W. A. Russell, second vice-president of the ASHVE, died here May 12.

Born in Chicago in 1886, Mr. Russell was graduated from the University High School, Chicago, and from the University of Michigan, Ann Arbor. Following his graduation he spent two years as superintendent of construction for the central manufacturing district in Chicago. Later he became associated with Spencer Heater Company, Chicago, as boiler salesman. After four years he joined the staff of the Mine & Smelter Supply Co., Denver, where he sold products of the U. S. Radiator Corp. In 1921 he became manager of the Kansas City branch office of the U. S. Radiator Corporation.

At the time of his death, Mr. Russell was district manager for Hoffman Specialty Co., with headquarters in Kansas City.



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Bethlehem Sheets make friends wherever they go. In heating and ventilating and general sheet-metal contracting shops, in plants where stamped and formed products are made, men who know their sheets know that Bethlehem Sheets show consistently top-notch performance.

Put the extra hand to work in *your* shop. Plan to use Bethlehem Sheets. There's a type and gage in this full line to suit your needs—and to do a bang-up job for you.

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BETHLEHEM STEEL

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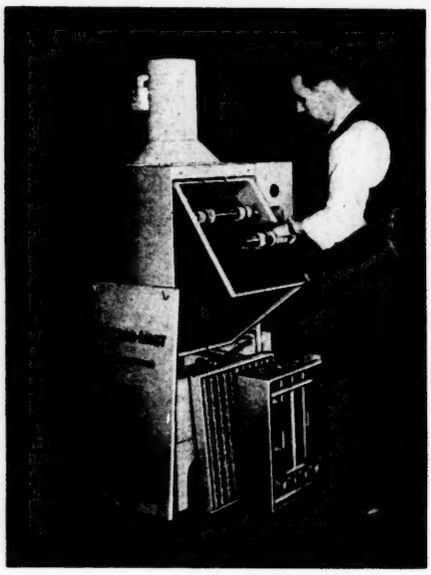
NEWS OF EQUIPMENT AND MATERIALS

Oil Mist Collector

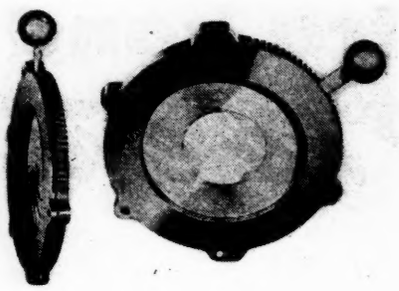
NAME—Electro-mist.
PURPOSE—Self-contained demountable electronic unit for collecting oil mist from high speed cutting tools, or welding fumes in light concentrations.
FEATURES—Axial flow fan mounted



on top of unit draws air from operation which is hooded through piping or flexible tubing into base of unit. In its application to cutting operations, mist-laden air first passes through permanent unit filter to remove metallic dust or large drops of oil, then enters ionizer in which mist and smoke particles receive electrical charge before passing into collector unit where they are precipitated on plates. Collected oil mist accumulates and drips off lower edge of plates, through filter and into reservoir below. As much as two or three gallons of oil can be salvaged daily and may be piped back into machine tool or drained off as preferred. Removable panel gives access to all parts which are removable. Operator is protected from possibility of electrical shock since turning latches to remove panel shuts off the current to power pack and charged parts are short circuited to remove any residual static charge. Filter and ionizing units slide out of casing and collector unit tilts forward permitting removal of collector plate assemblies for washing or inspection at any location convenient to water and sewer connections. The 7 inch diameter intake may be turned so as to enter from any side of casing and floor support, which provides space to drain oil pan. It may be omitted with overhead or wall mounting.
SIZES AND CAPACITIES.—One size, 28¾x20¾x70 in. high. Power pack operates from nominal 115 volts 60 cycle, single phase. On multiple installations one large power pack will handle as many as 10 collectors.
LITERATURE AVAILABLE.—Bulletin 251.
MADE BY—*American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Ky.*

Aero Valve

NAME—Aero valve.
PURPOSE — For air control in such applications as now require a butterfly type valve, particularly in the marine, air conditioning or bus transportation field.
FEATURES—Device is corrosion resistant, strong, with trouble-free operation for any air or heat control applications. Has 36 positive control stages, and is designed like a camera shutter, with 15 to 18 shutter segments. Its patented principle of assembly uses a minimum of wearing parts. Aluminum die cast cover and housing have anodized finish; all other parts are made of stainless steel. Knob on control lever is an AN standard part. Valve has passed a 50-hour concentrated salt spray test and operates without efficiency loss at temperatures varying from —65F to 400F above.
SIZES AND CAPACITIES — Available in



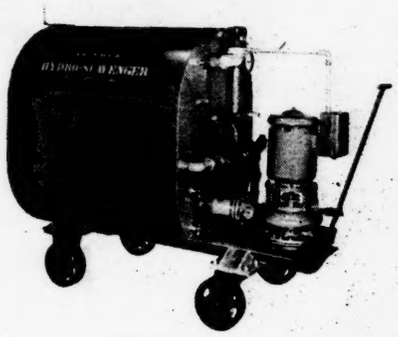
five sizes with openings from 2 to 7 in. in diameter.
MADE BY—*Smith-Mautz Co., Glendale, Calif.*

Acid-Resistant Glass

NAME — Hydrofluoric acid resistant glass.
PURPOSE — For such applications as gages, lenses, screens, ventilating fume hoods, and similar applications where resistance to hydrofluoric acid is necessary.
FEATURES—Although glass is slowly attacked by hydrofluoric acid, it reportedly retains its transparency throughout the attack, being based on phosphorus pentoxide instead of silica.
MADE BY—*American Optical Co., 1943 Thomas St., Southbridge, Mass.*

Hydro-Scavenger

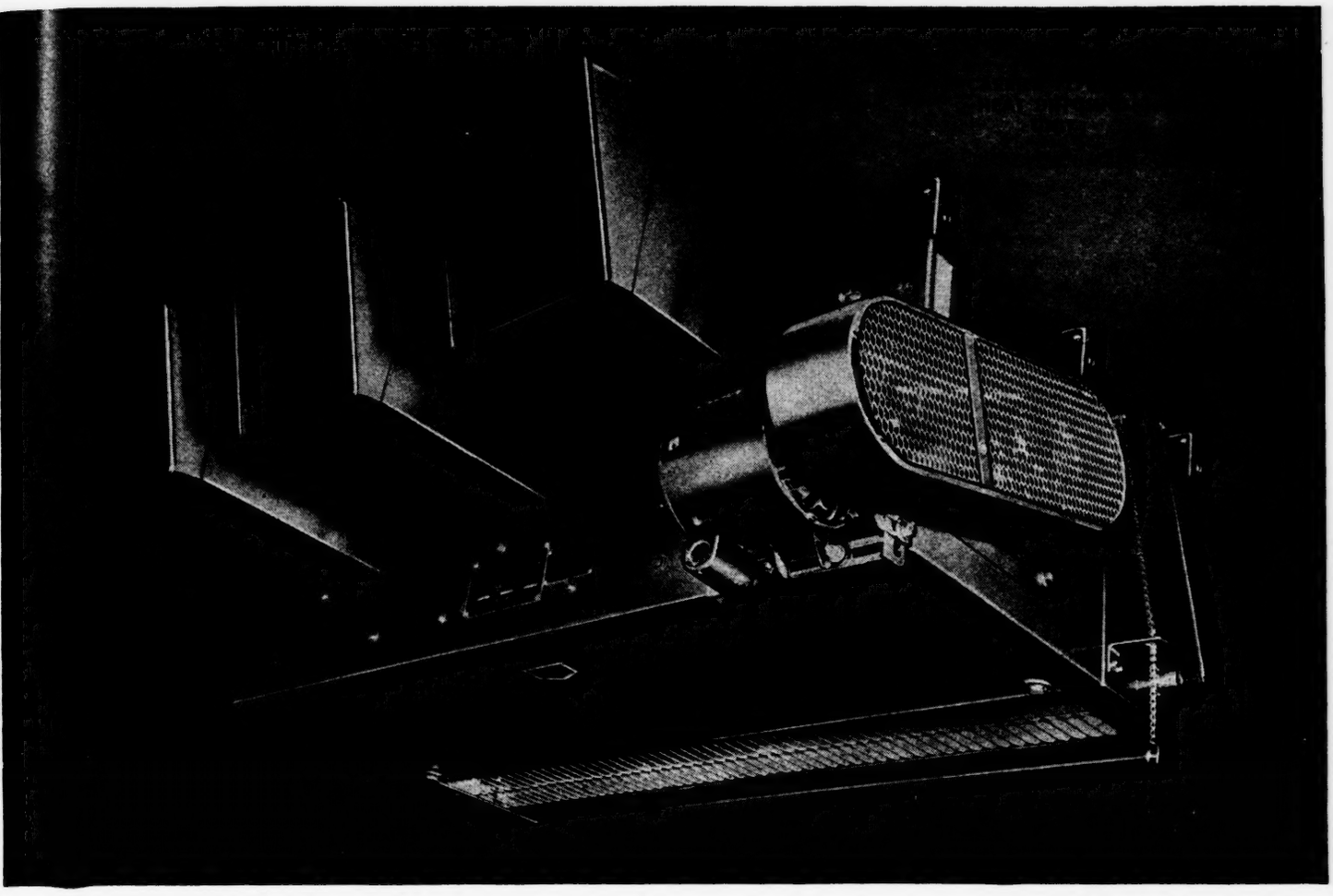
NAME—Hydro-Scavenger.
PURPOSE — Combination suction pressure machine with which operator may draw hard-to-handle materials up into vacuum receiver, switch to pressure, transport load to unloading



station and discharge contents under pressure without re-connecting electric current. Intended for such jobs as cleaning sumps of dust collectors, oil drums, cleaning water and scale from storage tanks, collecting magnesium dust and so forth.
FEATURES—As material being handled does not go through pump, abrasives and solids may be moved. Any liquid regardless of viscosity may be handled. Dust, lint and other dry materials may be collected. Access door is provided for dry removal or, if preferred, dry material may be collected under water and discharged as a sludge. Pump, which is conventional centrifugal type, creates both vacuum (28 in. maximum) for loading and air pressure for discharging. Machine operates on water-jet principle, involves no close clearances to wear, is built for heavy duty and has long life. Each unit undergoes 28 in. vacuum shut-off test before shipment. Almost any desired pressure is available for unloading.
SIZES AND CAPACITIES—Standard sizes are 50, 100 and 200 gallon capacity; other sizes can be furnished.
MADE BY—*Whittington Pump & Engineering Co., Indianapolis 4, Ind.*

Metal Cleaner

NAME—Troxide.
PURPOSE — De-rusting or pickling agent for metals.
FEATURES—Particularly intended to remove rust, scale, tarnish and incrustations of cement and lime, chemical is a dry, inert compound, non-eruptive and non-inflammable. Said to throw off no acid-mist or other toxic fumes.
MADE BY—*Waverly Petroleum Products Co., Drexel Bldg., Phila. 6, Pa.*



CARRIER HEAT DIFFUSERS...

Engineered as a complete unit for greatest economy

Like all Carrier space heating equipment, these blower type heat diffusers are designed throughout for true operating economies and efficiency.

The advantages of *experienced* engineering are evident in such superior features as: Selective air distribution . . . High outlet velocities . . . Wide, uniform heating coverage . . . Flexibility of arrangement and location . . . Rugged construction . . . No screwed joints or compression fittings . . . Ease of installation . . . Low maintenance costs.

Carrier Heat Diffusers, employing blower type fans, are highly effective for heating and ventilating enclosed spaces in factories, warehouses, hangars, garages, armories and similar structures. The type illustrated is for horizontal suspension from ceiling or truss work. Floor-mounted or vertical suspended units are also available.

Right *now* is the time to get in touch with Carrier engineers about prospective heating requirements. Practical suggestions from Carrier's experienced and trained technical staff can mean important savings for you. Write *today for complete information.*

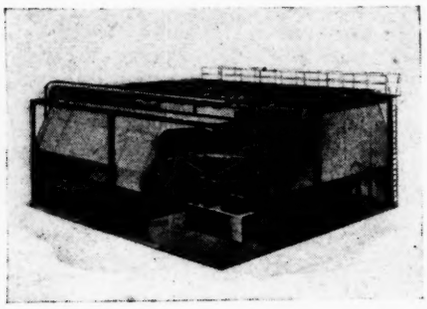
CARRIER CORPORATION · Syracuse, N. Y.

Carrier

AIR CONDITIONING • REFRIGERATION
INDUSTRIAL HEATING

Fin Fan Cooling Unit

NAME—Fin Fan cooling unit.
PURPOSE—A mechanical draft heat exchanger, air cooled, suitable for steam condensing, gas cooling, jacket



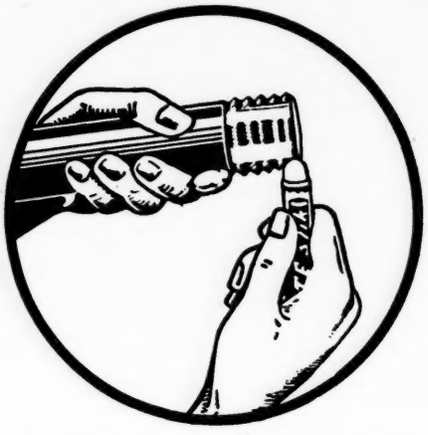
water cooling, and process applications.
FEATURES—Sections employ K-fin tube construction, cooled by forced draft fed by air from cooler layer at ground level and supplied by fans with variable pitch blades and with variable speed drive. Vertical air flow against static head assures even air distribution over cooling surfaces. Designed for pressures to 5,000 lb per sq in and temperatures to 1,500 F. Coils are located to provide sufficient static head for pump suction. Tubes can be removed and replaced quickly and all mechanical equipment is readily accessible from ground. Unit is designed by The Griscom-Russell Company and The Fluor Corporation, Ltd.
LITERATURE AVAILABLE — A 4-page standard size bulletin.
MADE BY—*The Fluor Corp., Ltd., 2500 S. Atlantic Blvd., Los Angeles 22, Calif.*

Electrode Holder

NAME—Armor-clad, insulated electrode holder.
PURPOSE—To accommodate electrodes up to and including ¼ in. diameter.
FEATURES — Head of holder is completely enclosed in a sheath of aluminum armor which protects the insulation, resists weld spatter, and eliminates the possibility of accidental contact with the welding circuit. Width of the electrode slot limits the size of electrode that can be inserted and thus prevents overloading. Threads of the push-up rod do not carry current. Holder weighs 15 ounces.
MADE BY—*General Electric Co., Schenectady, N. Y.*

Pipe Joint Compound

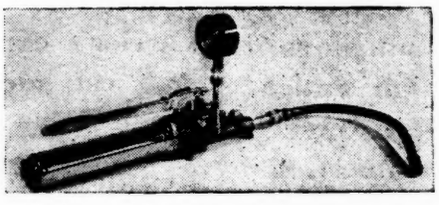
NAME—Pipetite-Stik.
PURPOSE—A pipe joint compound in easy-to-use stick form.
FEATURES—To use, rub stick across pipe threads for three or four strokes. It spreads and fills threads in turning. Encased in a cardboard holder, stick may be carried in pocket or tool kit. Compound is unaffected by air, water, steam, gas and acids. Prevents rust and inoreases thread



life. Said to withstand vibration, contains no lead.
MADE BY—*Lake Chemical Co., 607 N. Western Ave., Chicago 12, Ill.*

Pressure Gauge Tester

NAME—Multi-purpose pressure gauge tester.
PURPOSE—For bench testing or portable testing in the field of pressure gauges.
FEATURES—On bench testing unit can be used with test gauges or with a



dead weight attachment. Unique, but simple, doubly-sealed check valve, eliminates leakage and loss of pressure even with grit in the system, whether using oil or water and for pressures up to 10,000 lb per sq. in. Principal uses of testing unit include testing and repairing of pressure gauges and instruments, setting of relief or other pressure actuated valves and general hydrostatic tests.
MADE BY—*Mansfield & Green, Cleveland, Ohio.*

Refrigerant Drier-Filter

NAME—Trap-Dri.
PURPOSE — Combines filter and dehumidifier for refrigerating systems.
FEATURES—Easy to install in any part

of the system but most effective ahead of expansion valve. Said to stop all impurities in refrigerant lines. Absorbs 12 to 16 times its own weight in water with filter as effective as a 900 mesh strainer. Stocked and sold by refrigeration parts jobbers.
MADE BY — *Automatic Products Co., Milwaukee, Wis.*

Dravo Suspended Heater

NAME—Dravo direct-fired heater, suspended type.
PURPOSE—Gas or oil-fired unit heater for suspension from walls or roof trusses and for use in cases where space for the conventional type floor units is not available.
FEATURES—Warm air from the heater can be discharged in any direction by regulating adjustment of nozzles. There are directional louvers on each nozzle to direct flow up or down. Hot air is driven from the adjustable nozzles at velocities of 1800 to 2000 ft per minute, enabling heaters to be located from roof trusses or wall brackets 30 or more feet above the floor, and still deliver heat efficiently to working area. Combustion takes place in a tear-drop shaped combustion chamber, lower half of which is lined with plastic refractory molded to metal wall. System of passes brings air to be heated in contact with heating elements four times. Heaters are shipped from factory complete with refractory lining and all wiring in place.
SIZES AND CAPACITIES — 300,000 to 1,650,000 Btu per hr.
MADE BY—*Dravo Corp., Pittsburgh 22.*

Liquid Belt Dressing

NAME—Grake liquid belt dressing.
PURPOSE—To restore power transmission to transmission belts.
FEATURES—Makers claim that the dressing will increase power transmission 15 to 20% for belts that are pulling under their rating.
MADE BY—*Graton and Knight, Worcester 4, Mass.*

This is No. 6 in a series of 6 Advertisements, setting forth values of the adequacy, simplicity, flexibility, dependability and economy of the Dunham Differential Vacuum Heating System.

All Three are Satisfied Only When ECONOMY *is linked with* EFFICIENCY

The satisfaction of tenant, operator and owner in a heating system is the criterion whereby one may measure the efficiency and economy of the system. There is Efficiency when the *tenant or worker* being conscious only of comfort—not heat, is satisfied. There is Economy when the *operating management* is satisfied because he provides that comfort with a minimum fuel use and minimum use of man-power for control and maintenance.

And, when this economy and efficiency are present, the *owner* can see a good return on his investment and justification for his continued interest. Not fuel savings alone, not tenant comfort alone, nor yet profit on investment alone, indicate the ideal heating system but the functional combination that meets the requirements of all three. This is the basis upon which a heating system should be adjudged.

Dunham Differential Heating has a record of many years for unchallenged supremacy in every type of building for insuring tenant satisfaction by its unvarying comfort-conditioning, accomplishing this with such fuel and maintenance savings that owners from coast to coast endorse it as the soundest heating system investment.

★

Performance data in new and changed-over buildings gladly furnished. Just ask for Bulletin 636. C. A. Dunham Company, 450 E. Ohio St., Chicago 11, Ill.

DUNHAM

DIFFERENTIAL HEATING

CHICAGO • TORONTO • LONDON

REVIEWS

Articles are abstracted for the convenience of the readers. Orders cannot be taken for the full length articles. Those desiring to obtain copies of the article referred to should write to the publishers of the respective articles.

HEAT LOSSES FROM SLAB FLOORS

In "Measurements of Heat Losses from Slab Floors," Richard S. Dill, William C. Robinson and Henry E. Robinson present data obtained by the National Bureau of Standards in testing eight floors. These tests indicated that as far as warmth or heat loss is concerned, a concrete floor may as well be placed on the ground as to be laid over an unheated crawl space. However, a floor laid over a closed crawl space containing heating pipes or ducts, would be more comfortable in winter than one laid over an unheated space.

Insulation at the edge of the floor is much more important for floors laid on the ground, so far as warmth in winter is concerned, than insulation under the center of the floor.

Tests described in the report were made with special reference to small houses, but the authors believe that there is no reason why the results would not be as applicable to large structures.

The paper gives quantitative information that may be used for estimating heat losses through floors.

Paper bound, 21 pages and cover. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 10 cents.

BUILDING EQUIPMENT

Since the publication of "Mechanical and Electrical Equipment for Buildings," in 1935, there have been considerable advances in the field, and a new edition was necessary.

The authors cover such widely diverse material as water supply, plumbing and drainage, heating and air conditioning, electrical equipment, and acoustics—all important to engineers concerned with building maintenance.

The important changes since the first edition are that data on air conditioning have been revised. Major changes have also been made in the chapters on elevators, lighting and acoustics.

While the authors do not intend the volume to be a handbook, they attempt to provide the basic theories and applications concerned with building equipment, for the building managers, architects, and students. The section on heating and air conditioning covers 150 pages.

Mechanical and Electrical Equipment for Buildings, by Charles Merrick Gay and Charles De van Fawcett. Cloth covered, 5½x8½ in., 453 pages. Published by John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y. Price, $5.

BUILDING INSULATION

For a complete treatment of the subject of building insulation, the book by Paul D. Close is recommended. The author has had an extensive experience in this specialized field. For more than 10 years he was with Celotex Corp., and for 2½ years with Johns-Manville Co. He has lectured on the subject of heating, ventilating and air conditioning and has contributed articles to the technical press.

It is possible that many may be well acquainted with the first edition of Building Insulation. A number of important changes have been made in this, the second edition.

The book covers thermal building insulations, methods of application, fundamentals of heat transfer through building materials, transmission coefficients and tables, calculating heat losses, effect of building insulation on heating plant size, fuel saving, economics of insulation, expansion of roofs, condensation, insulation and comfort, pipe and duct insulation, sound insulation, machinery isolation, architectural acoustics and noise quieting, and questions pertaining to building insulation.

Building Insulation, by Paul D. Close, cloth bound, 5½ x 8½ in., 328 pages. Published by American Technical Society, Drexel Ave. at 54th St., Chicago 37, Ill. Price, $3.50.

BRIEF REVIEWS

CONDENSING UNITS—A printed pamphlet entitled Commercial Electric-Refrigeration Condensing Units, Commercial Standard CS107-45, which has been accepted by the industry as its standard of practice for new products beginning six months after cessation of hostilities. Paper covered, size 5¾ x 9 in., 16 pages. Published by U. S. Department of Commerce, National Bureau of Standards. Available from Sup't of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 10 cents.

HEALTH HAZARDS OF SOLDERING.—All soldering operations have a health hazard because of the lead used. The various types of soldering operations are described in a booklet "Health Hazards in Soldering Operations," published by the Michigan Department of Labor and Industry, Lansing, Mich. The material was obtained from the Illinois Department of Labor and appeared as a reprint in *Michigan Labor and Industry*, the department's publication, before appearing as a 15-page bulletin. The report discusses both hand and machine soldering, points out the hazards, and the measures that should be taken to provide the best working conditions.

DOUGLAS FIR PLYWOOD—Article from *The Timberman* on plywood boat construction in which various parts of boat construction are described; another article from the same publication on plywood research reviewing the studies undertaken by the Douglas Fir Plywood Association. Both reprints may be obtained from the association, Tacoma Building, Tacoma 2, Wash.

DUST EXPLOSIONS—Information Circular 7309 of the Bureau of Mines, reviewing the industrial dust explosion hazards and briefly summarizing the conditions under which explosions occur and the extent of the hazard with various types of dust. Closes with a discussion of dust explosion preventions and protection. Mimeographed.

Your Plans for Postwar Expansion and Modernization Will Include Refrigeration and Air-Conditioning . . . All Requirements Will Be Met By

CURTIS

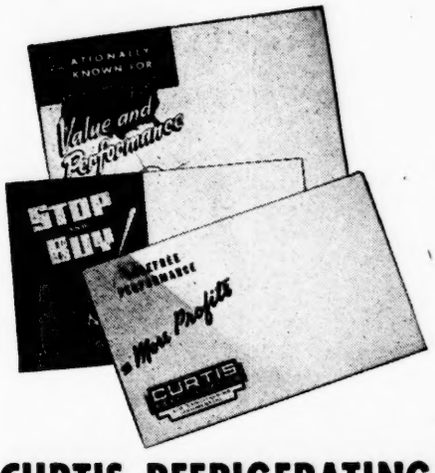
COMMERCIAL REFRIGERATION AND AIR-CONDITIONING UNITS

Users attest to the dependable, trouble-free, and economical performance of Curtis Equipment.

Just as Curtis is today planning about to add new units and to improve and refine many features to keep pace with postwar demand, you, too, should be seriously thinking of the postwar market for air conditioning and refrigeration equipment.

All reports definitely prove the fact that of all industries scheduled for postwar expansion, air conditioning and refrigeration are close to the top. You can get your share of this business by laying a solid foundation *now*, and you can count on Curtis to assist you in every way possible.

Today, all Curtis Units except packaged air-conditioners are available under proper allocation. When Victory is won, the complete Curtis line, improved, up-to-the-minute, and reflecting the experience gained over 91 years, will be ready for you. But — start planning now!



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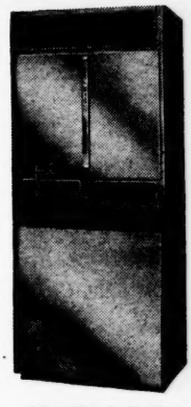
You'll be interested in reading about the possibilities in the field of air conditioning and refrigeration. Write today for Bulletins C-64-E, C-68-C, and C-14-M, covering this interesting and profitable business.



5-hp. Curtis Packaged Air-Conditioner

7½ hp. Curtis Condensing Unit

15-hp. Water-cooled, Shell and Tube Condensing Unit

CURTIS REFRIGERATING MACHINE DIVISION

of Curtis Manufacturing Company

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FOR VICTORY BUY MORE U. S. WAR BONDS AND STAMPS

Degree-Days for April, 1945

HEATING AND VENTILATING'S 18TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	APRIL			CUMULATIVE, SEPTEMBER 1 TO APRIL 30			HEATING SEASON[1]
	1945	1944	NORMAL	1945	1944	NORMAL	NORMAL
Abilene, Texas	155	88	27	2447	2512	2061	2061
Albany, New York	437	694	549	6433	7010	6397	6580
Albuquerque, New Mexico	379	386	288	4262	4775	4258	4298
Alpena, Michigan	642	846	789	7097	7468	7662	8299*
Anaconda, Montana	884	704	756	7351	7285	7493	8357**
Asheville, North Carolina	226	323	330	3592	4152	4161	4232
Atlanta, Georgia	108	181	132	2740	2905	2890	2890
Atlantic City, New Jersey	364	492	519	4552	4815	4956	5176
Augusta, Georgia	43	130	24	2063	2259	2161	2161
Baker, Oregon	685	615	615	6216	6308	6519	7163
Baltimore, Maryland	216	361	348	4086	4420	4511	4533
Billings, Montana	715	492	534	6415	6146	6743	7119
Binghamton, New York	419	661	594	6207	6821	6554	6808
Birmingham, Alabama	111	168	69	2558	2873	2352	2352
Bismarck, North Dakota	752	689	657	7934	7819	8809	9192
Block Island, Rhode Island	491	647	633	5236	5526	5311	5788
Boise, Idaho	568	488	435	5378	5611	5316	5552
Boston, Massachusetts	388	608	570	5390	5865	5800	6045
Bozeman, Montana	866	615	731	7211	7265	7724	8521**
Buffalo, New York	476	721	675	6228	6774	6475	6822
Burlington, Vermont	469	788	654	7205	7872	7238	7514
Butte, Montana	895	742	741	7629	7855	7424	8272
Cairo, Illinois	141	226	201	3684	3903	3909	3909
Canton, New York	491	782	684	7462	7908	7686	8020
Charles City, Iowa	574	631	612	6934	7162	7364	7588
Charleston, South Carolina	24	95	36	1773	1870	1769	1769
Charlotte, North Carolina	112	187	159	2929	3106	3120	3120
Chattanooga, Tennessee	140	232	144	3273	3539	3118	3118
Cheyenne, Wyoming	908	819	720	6783	6952	6894	7466
Chicago, Illinois	461	590	537	5644	6245	5715	5957
Cincinnati, Ohio	274	347	333	4736	4869	4684	4684
Cleveland, Ohio	400	596	564	5569	5878	5935	6155
Columbia, Missouri	311	419	303	4716	5120	4900	4922
Columbia, South Carolina	57	132	63	2266	2461	2364	2364
Columbus, Ohio	332	428	420	5110	5308	5311	5398
Concord, New Hampshire	481	760	669	6836	7441	7001	7353
Concordia, Kansas	435	534	342	4833	5526	5250	5315
Dallas, Texas	107	85	9	2200	2418	2256	2256
Davenport, Iowa	406	533	453	5676	6054	6171	6289
Dayton, Ohio	365	472	396	5441	5692	5183	5264
Denver, Colorado	683	651	534	5256	5568	5607	5874
Des Moines, Iowa	451	568	441	5808	6267	6266	6384
Detroit, Michigan	448	665	573	5898	6417	6264	6490
Devils Lake, North Dakota	852	742	756	8591	8786	9450	9970
Dodge City, Kansas	459	508	342	4782	5413	4988	5035
Dubuque, Iowa	466	593	489	6191	6550	6641	6790
Duluth, Minnesota	864	841	801	8243	8558	8746	9443
Eastport, Maine	677	803	786	6832	7418	7398	8520**
Elkins, West Virginia	346	503	501	5418	5721	5520	5697
El Paso, Texas	148	112	45	2545	2802	2428	2428
Ely, Nevada	826	806	—	7264	7339	—	—
Erie, Pennsylvania	419	671	609	5545	6217	6016	6273
Escanaba, Michigan	780	828	828	7618	7736	8118	8771*
Evansville, Indiana	249	317	276	4431	4693	4244	4244
Fort Smith, Arkansas	132	151	93	2994	3204	3147	3147
Fort Wayne, Indiana	450	609	474	6049	6447	5795	5925
Fort Worth, Texas	115	79	27	2225	2369	2148	2148
Fresno, California	187	216	135	2666	2538	2334	2334
Galveston, Texas	33	20	0	974	1161	1016	1016
Grand Junction, Colorado	513	509	384	4914	5311	5430	5548
Grand Rapids, Michigan	470	625	534	5852	6398	6361	6535
Green Bay, Wisconsin	589	730	600	7023	7366	7503	7825
Greensboro, North Carolina	169	270	210	3639	4026	3529	3529
Greenville, South Carolina	112	196	195	2919	3145	3380	3380
Harrisburg, Pennsylvania	320	484	405	5013	5457	5285	5375
Hartford, Connecticut	357	598	531	5822	6198	5834	6036
Hatteras, North Carolina	100	186	255	2614	2721	2571	2571
Havre, Montana	764	498	630	7607	6904	8187	8700
Helena, Montana	774	623	646	7346	7343	7261	7898
Houston, Texas	36	22	0	1152	1300	1157	1157
Huron, South Dakota	638	671	570	7039	7545	7737	8004
Indianapolis, Indiana	337	423	384	4995	5301	5239	5298
Jackson, Miss.	62	—	—	2039	—	—	—
Kansas City, Missouri	326	448	306	4516	5104	4950	4956
Kewanee, Illinois	394	575	472	5516	6408	5996	6139
Knoxville, Tennessee	178	257	210	3455	3667	3670	3670
La Crosse, Wisconsin	593	534	528	6756	7205	7139	7322
Lander, Wyoming	948	719	690	8126	8025	7384	7947

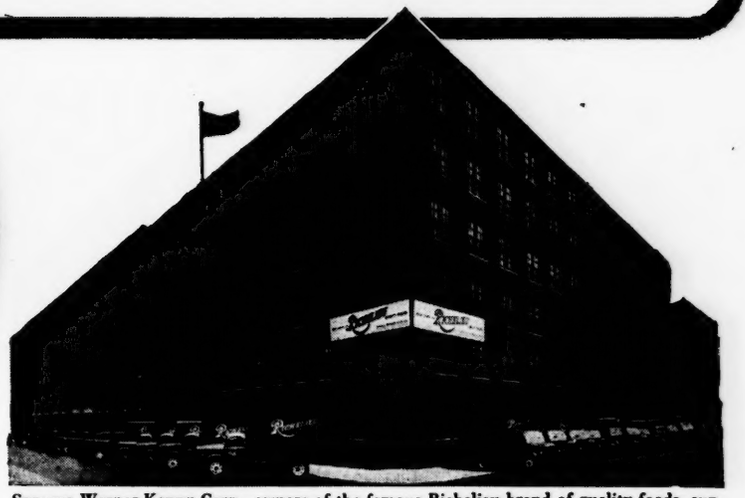
[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp. Kewanee, Ill., Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, Box 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

(a) Data not available.

[Table concluded on page 114]

SAVING FUEL IS OUR BUSINESS



Sprague Warner-Kenny Corp., owners of the famous Richelieu brand of quality foods, supplies 60,000 grocers. Its head, Mr. Nathan Cummings, has achieved phenomenal success through his ability not only to build a progressing organization, but also through his skill in eliminating waste. His selection of Iron Fireman firing is a typical example of his ingenuity.

$12,714 a Year Saved for RICHELIEU

★ It's always good business to save fuel. Now it is a good way to serve our country, too. Fuel saving is a wartime "must." So there is a patriotic thrill today for plant owners and engineers who can make a genuine reduction in fuel consumption. Especially when lower costs are accompanied by improvements in boiler room efficiency.

This happened at the Chicago plant of Sprague Warner-Kenny Corp., home of the famous Richelieu brand of quality foods. Steam formerly cost 62c per thousand lbs. After installing Iron Fireman it cost only 26¼c—58% saving. Fuel and labor savings amount to $12,714 a year!

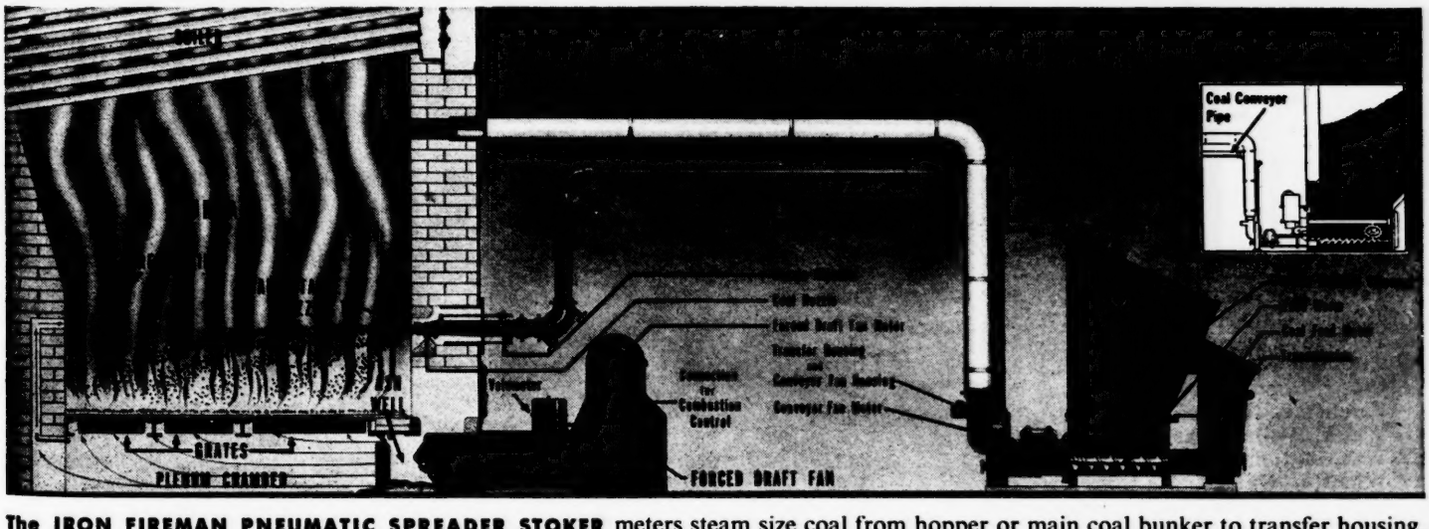
America is a stronger nation because of the job Iron Fireman is doing at Sprague Warner-Kenny Corp. plant. America would be still stronger if a way could be found to make *your* plant more efficient. Perhaps it can be done. We will make a survey without cost or obligation on your part.

IRON FIREMAN

AUTOMATIC COAL STOKERS

Industrial . . . Commercial . . . Residential

Our nationwide organization of qualified factory representatives and dealers is at your service. For a free survey showing what Iron Fireman firing can do in your building or plant, write Iron Fireman Mfg. Co., 3805 West 106th St., Cleveland 11, Ohio.



The IRON FIREMAN PNEUMATIC SPREADER STOKER meters steam size coal from hopper or main coal bunker to transfer housing, where coal is picked up by pneumatic conveyor and delivered to furnace. The conveyor nozzle accurately spreads the larger particles of coal over the entire grate in a shallow, uniform fuel bed. The preheated fines burn in suspension, reducing the cinder carry-over and greatly improving the combustion efficiency and responsiveness, as compared with other stokers which do not preheat the fuel.

Degree-Days for April, 1945 (Concluded)

HEATING AND VENTILATING'S 18TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	APRIL			CUMULATIVE, SEPTEMBER 1 TO APRIL 30			HEATING SEASON[1]
	1945	1944	NORMAL	1945	1944	NORMAL	NORMAL
Lansing, Michigan	499	696	582	6427	7003	6819	7048
Lewiston, Maine	526	757	693	7058	7813	7318	7707
Lincoln, Nebraska	448	581	417	5268	5968	5900	5999
Little Rock, Arkansas	104	152	78	2970	3095	2811	2811
Livingston, Montana	789	632	653	6621	6466	6638	7205
Los Angeles, California	178	184	159	1402	1309	1414	1504
Louisville, Kentucky	230	283	264	4171	4317	4180	4180
Lynchburg, Virginia	215	279	273	4058	3931	3980	3980
Macon, Georgia	61	140	33	2112	2363	2201	2201
Madison, Wisconsin	541	672	582	6637	7073	7193	7429
Marquette, Michigan	754	849	804	7324	7724	7968	8693*
Memphis, Tennessee	135	179	96	3118	3204	2950	2950
Meridian, Mississippi	66	118	24	2191	2357	2160	2160
Milwaukee, Wisconsin	562	733	648	6431	6993	6856	7245
Minneapolis, Minnesota	634	659	570	7166	7424	7614	7850
Modena, Utah	647	662	579	6065	6334	6170	6562
Montgomery, Alabama	58	98	0	1803	2041	1884	1884
Nantucket, Massachusetts	472	631	639	5134	5486	5450	5957
Nashville, Tennessee	166	241	180	3548	3666	3507	3507
New Haven, Connecticut	389	601	543	5591	5973	5672	5895
New Orleans, Louisiana	30	40	0	985	1232	1024	1024
New York, New York	311	509	486	4748	5271	5192	5347
†Nome, Alaska	1959	1816	1756	9954	10084	10642	14580**
Norfolk, Virginia	149	247	246	3161	3420	3350	3350
North Head, Washington	563	494	516	3985	3916	4271	5452**
North Platte, Nebraska	575	618	486	5680	6255	6167	6366
Oakland, California	285	362	273	2711	2650	2665	3143**
Oklahoma City, Oklahoma	243	229	162	3346	3612	3613	3613
Omaha, Nebraska	454	568	414	5648	6238	6047	6131
Oswego, New York	478	760	675	6297	6914	6668	7088
Parkersburg, West Virginia	268	381	351	4753	5005	4722	4775
Peoria, Illinois	404	529	453	5673	6137	5988	6109
Philadelphia, Pennsylvania	245	440	402	4413	4801	4787	4855
Phoenix, Arizona	89	51	0	1555	1519	1405	1405
Pittsburgh, Pennsylvania	295	449	423	4911	5330	5157	5235
Pocatello, Idaho	675	640	567	6494	6689	6263	6655
Portland, Maine	542	780	666	6895	7417	6771	7218
Portland, Oregon	405	372	402	3804	3775	4134	4469
Providence, Rhode Island	330	566	558	5150	5690	5764	6015
Pueblo, Colorado	605	633	456	5389	5814	5328	5514
Raleigh, North Carolina	117	205	183	3155	3423	3234	3234
Rapid City, South Dakota	732	676	594	6654	6967	6744	7118
Reading, Pennsylvania	292	473	417	4871	5267	5293	5389
Red Bluff, California	171	—	—	2596	—	—	—
Reno, Nevada	580	635	534	5514	5641	5436	5892
Richmond, Virginia	169	270	246	3592	3917	3695	3695
Rochester, New York	457	745	618	6417	6927	6472	6732
Roseburg, Oregon	429	431	411	3788	3903	4047	4428
Roswell, New Mexico	265	223	180	3282	3606	3484	3484
Sacramento, California	180	276	207	2579	2524	2600	2653
St. Joseph, Missouri	376	488	342	4859	5456	5145	5161
St. Louis, Missouri	253	343	276	4408	4623	4585	4585
Salt Lake City, Utah	603	533	453	5140	5940	5319	5555
San Antonio, Texas	61	27	0	1543	1671	1202	1202
San Diego, California	200	164	174	1416	1284	1524	1645
Sandusky, Ohio	399	617	726	5551	5933	6025	6208
San Francisco, California	275	354	294	2330	2199	2417	3264**
Sault Ste. Marie, Michigan	760	881	819	8133	8396	8448	9285**
Savannah, Georgia	23	73	0	1465	1528	1490	1490
Scranton, Pennsylvania	384	604	513	5831	6260	5958	6129
Seattle, Washington	485	398	462	3842	3839	4379	4934**
Sheridan, Wyoming	774	574	648	6865	6906	7485	8008
Shreveport, Louisiana	51	79	0	2067	2224	1938	1938
Sioux City, Iowa	548	620	489	6324	6849	6734	6898
Spokane, Washington	608	512	504	5752	5893	5989	6355
Springfield, Illinois	321	427	366	5437	5353	5317	5373
Springfield, Missouri	285	386	267	4406	4742	4416	4428
Syracuse, New York	435	715	630	6357	7008	6614	6893
Tacoma, Washington	513	434	465	4212	4253	4551	5181**
Terre Haute, Indiana	309	383	333	4813	5130	4872	4872
Toledo, Ohio	447	654	525	6091	6480	5897	6077
Topeka, Kansas	347	446	300	4509	5067	4935	4969
Trenton, New Jersey	276	482	402	4808	5273	4852	4933
Utica, New York	436	726	588	6788	7434	6543	6796
Valentine, Nebraska	666	699	561	6603	7071	6766	7039
Walla Walla, Washington	421	365	363	4498	4835	4637	4808
Washington, D. C.	197	342	348	4108	4441	4601	4626
Wichita, Kansas	371	398	252	4312	4695	4673	4673
Williston, North Dakota	800	644	669	7981	7821	8907	9323
Winnemucca, Nevada	627	623	539	5915	6055	5950	6427**
Yakima, Washington	439	394	360	4961	5214	5413	5599

†Nome data are for March.
(a) Data not available.

*Includes August.
**Includes July and August.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

A DUST-STOP*

IN THE BANK IS WORTH

TWO IN THE STOCK ROOM

Banks of DUST-STOPS are a sure sign of economical and efficient air filtering, in heating and air conditioning systems. One of the many reasons for the widespread preference for these efficient air filters is their low-cost installation and easy, quick replacement, from conveniently located stocks.

It is more economical to replace DUST-STOPS, when they become heavily loaded with dirt, than not to use them at all—or to continue to use them after they have served their purpose.

Costs Are Figured Two Ways

To many concerns, unnecessary cost burdens are added simply by a lack of adequate air filtering. To others, excessive operating and maintenance costs are imposed by the *type* of air filtering equipment used.

Economical DUST-STOPS and the complete, ready-to-assemble steel cell frames are adaptable to virtually any system, regardless of cfm requirements.

High efficiency is easily and economically maintained by replacement from conveniently located stocks.

It's Smart To Look Ahead

A minimum of manpower and time are required in replacing DUST-STOPS—and they can be obtained quickly from near-by suppliers.

Where maintenance loads are toughest or where peak loads are involved, many Dust-Stop users keep an adequate supply on hand. And replacement requires no special tools or talents.

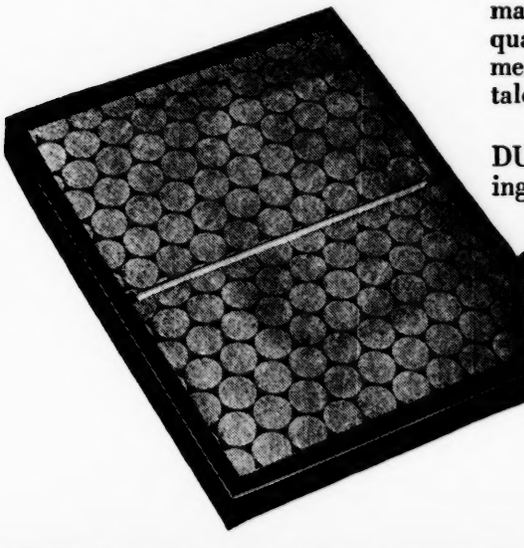
Efficiency Pays

DUST-STOPS provide high air filtering efficiency. They are constructed of packs of glass fibers (Fiberglas*), coated with an adhesive, faced with a metal grille, and bound on the edge with a fiberboard frame.

The Fiberglas fibers, packed to proper density, form an exceptionally effective medium for air filtration. Being glass, they are inorganic, chemically stable, resistant to heat and corrosive vapors. And being of glass, they do not absorb the nonodorous nonevaporating adhesive with which they are coated. Each impinged particle of dust is quickly soaked, acting as a wick to carry adhesive to other particles. Thus, the adhesive remains effective until the filter is so heavily loaded with dust that resistance to air flow calls for replacement.

If you do not have complete information on DUST-STOP Air Filters, or typical installation details, see Sweet's Files or write: *Owens-Corning Fiberglas Corporation, 1912 Nicholas Building, Toledo 1, Ohio.*

In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.



DUSTOP AIR FILTERS

*T. M. REG. U. S. PAT. OFF.

ARMY E NAVY

—a FIBERGLAS product

Getting Personal

V. T. Stringfield

V. T. Stringfield (Ground Water for Cooling and Other Industrial Uses, page 61) was born in Franklinton, La. He received his B. S. from Louisiana in 1925 and his M. S. in 1927 from Washington University.

He was an instructor in geology at Oklahoma A. & M. College 1927 to 1928, and for the next two years, assistant professor at the New Mexico School of Mines.

While in New Mexico he was geologist for the New Mexico Bureau of Mines.

Mr. Stringfield served as assistant geologist, U. S. Geological Survey, 1930-1936; associate geologist, 1936-1939; geologist in charge of ground water investigations in southeast states 1939-1943, and senior geologist since 1943.

E. N. Kemler, one of the authors of "Isolating Vibrations in Mechanical Equipment," page 83, received his B.S.M.E. and M.E. degrees from the University of Kansas, and his M.S. and Ph.D. degrees from the University of Pittsburgh.

From 1927 to 1929 he was employed by the Dodge Manufacturing Co., Mishawaka, Ind. From 1929 to 1936 he served as instructor and Assistant Professor of Mechanical Engineering at the University of Pittsburgh, Pittsburgh, Pa. During this time he also attended the Westinghouse Design School.

During 1930-1936 he was employed as part time research engineer for the Gulf Research and Development Corp. For the next four years he was employed by the Gypsy Division of the Gulf Oil Corp., Tulsa, Okla., in production engineering work and as chief production engineer.

From 1940 on he has served as Professor of Mechanical Engineering, Purdue University, Lafayette, Ind.

E. N. Kemler

C. R. Freberg

C. R. Freberg, co-author with Dr. Kemler, was born in Minnesota in 1916 and studied for his undergraduate and master's degrees at the University of Minnesota. His doctorate degree was obtained at Purdue University.

He has been successively instructor in Mechanical Engineering at the University of Minnesota, instructor in Mechanical Engineering and Assistant Professor of Mechanical and Aeronautical Engineering at Purdue University.

He is also co-author with Doc. Kemler of "Elements of Mechanical Vibration" and "Aircraft Vibration and Flutter," both published by John Wiley and Sons.

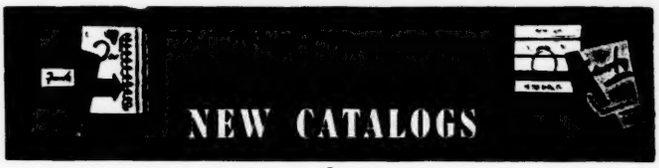
"Heat Losses from Insulated Air Ducts," page 78, is the result of studies made by the late **Ensign Charles Hunt Kilpatrick** while a student at the University of California.

C. H. Kilpatrick

A graduate of the Los Angeles High School, he enrolled in the Engineering School, University of California, from which he graduated with honors in February, 1944.

He was elected to Tau Beta Pi, honorary engineering fraternity, a member of Scabbard and Blade, honorary military organization, and Sigma Xi, honorary scientific society.

He received his commission in the U. S. Naval Reserve, and was immediately assigned to the destroyer, U. S. E. Johnston. He died from wounds received in a battle off Samar Island, October 25, 1944.



Steel Pipe Research

In "Research Points the Way," a 12-page booklet, is told the advances that have been made in the use of steel pipe. It deals mainly with steel pipe which is used for plumbing and heating in the housing, building, construction and industrial fields.—*American Iron and Steel Institute, 350 5th Ave., New York 1, N. Y.*

Automatic Stokers

Eight-page booklet illustrated in color describing the line of Winkler automatic stokers. Specifications are given for domestic and industrial models, and for bituminous and anthracite coal.—*U. S. Machine Corp., Lebanon, Ind.*

Underground Pipe Conduit

Bulletin 451, "Therm-O-Tile, the Conduit for Underground Pipe Lines," covers the four main advantages of this type of conduit construction. A modified design for use in exceptionally wet or submerged location is illustrated.—*H. W. Porter & Co., Inc., 825 Frelinghuysen Ave., Newark 5, N. J.*

Fiberglas

Eight-page illustrated folder for design engineers presenting facts about fiberglas as to forms and sizes, major properties and principal uses. The material comes in various forms and each type is treated separately.—*Owens-Corning Fiberglas Corp., Toledo, Ohio.*

Gas Controls

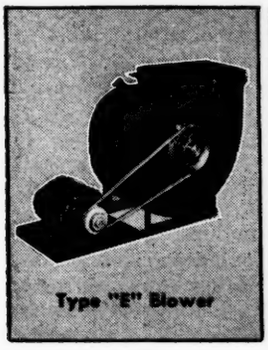
A 32-page manual on the application and operation of automatic gas heating controls has just been published. It includes many applications of gas control valves, with detailed drawings showing their specific applications on various hook-ups. The drawings are made in perspective to permit easy interpretation.—*General Controls, 801 Allen Ave., Glendale 1, Cal.*

Hooks for Flat Belting

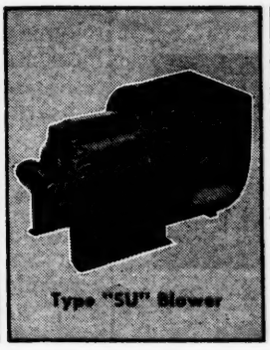
A bulletin, containing many illustrations, has been released to describe a line of wire belt hooks for all types of flat belting.—*The Bristol Co., Waterbury 91, Conn.*

NATIONAL SERVICE
on Quality Blowers

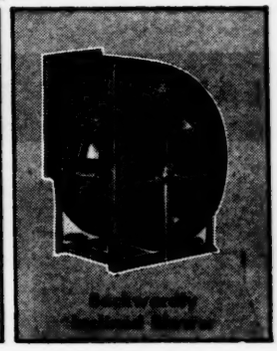
A SIZE AND TYPE FOR EVERY JOB REQUIREMENT


Type "E" Blower

Forwardly Curved Blower


Type "SU" Blower

Maritime Blower



Wherever you are—North, South, East or West, usAIRco is ready to serve your needs with Blowers of proved design, capacities and performance. usAIRco blowers are serving every conceivable need for land, sea and air. Its maritime blowers are meeting all requirements in the most exacting kind of service, Sea Duty. A crack design staff, modern factory and two decades of experience assure you satisfaction of product and reasonable delivery. We'll be glad to receive your inquiries.

UNITED STATES AIR CONDITIONING CORPORATION

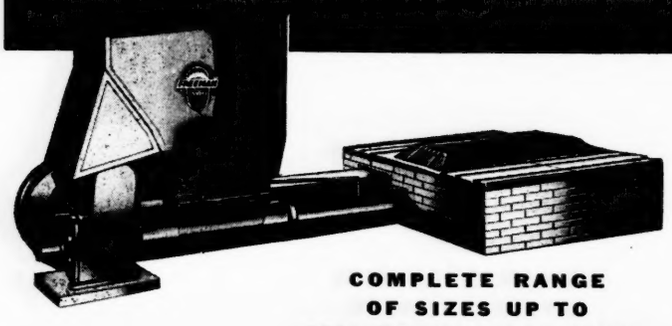
MANUFACTURERS OF THE MOST COMPLETE LINE OF AIR CONDITIONING EQUIPMENT AND COMPLETE UNITS

NORTHWESTERN TERMINAL MINNEAPOLIS 13, MINN.

WHY WAIT FOR POST-WAR?

FREEMAN STOKERS

FIRST CHOICE OF AMERICA'S FOREMOST HEATING ENGINEERS



COMPLETE RANGE OF SIZES UP TO 1200 POUNDS PER HOUR

FREEMAN STOKER DIVISION
ILLINOIS IRON & BOLT CO.
918 S. MICHIGAN AVE., CHICAGO 5, ILLINOIS

Jobs for the War Disabled

The war disabled veteran can be safely and economically employed by industry. Where such veterans have been hired, records show that such persons have had fewer accidents, fewer absences, fewer resignations, and fewer discharges for cause. All this is explained in a leaflet, "Jobs for the War Disabled."—*The American Veterans Association, 271 Madison Ave., New York 16, N. Y.*

Handbook of Branch Pipe Outlets

A 32-page pocket size manual of branch pipe outlets. It explains the 4 steps in installing pipe outlets by the WeldOlet method, and illustrates the tools required to make the joint. Fittings available are for butt-welded, threaded, and socket-welded branch pipes.—*Bonney Forge & Tool Works, Dept. 220, Allentown, Pa.*

Solenoid Valves

Circular No. 200, of 12 illustrated pages, describes a line of solenoid valves for the automatic and remote control of the flow of liquids and gases.—*Automatic Switch Co., 41 East 11th St., New York 3, N. Y.*

Metal Cleaners

Eight-page bulletin covering Klem Kleaners and Klem Products for cleaning, derusting, metal cleaning and degreasing, and metal preparation for finishing.—*Klem Chemical Works, 1500-18 E. Woodbridge St., Detroit 7, Mich.*

Resistors and Radiant Heaters

Specification folder for Regan resistors with glazed steatite cores, and for Regan radiant heaters for temperatures to 1700F.—*Techtmann Industries, 828 N. Broadway, Milwaukee 2, Wis.*

Welding Equipment

A 6½ page article showing by photographs step by step information on how to recondition cutting nozzles and welding heads. — *Oxy-Acetylene Tips, The Linde Air Products Company, 30 E. 42nd St., New York 17, N. Y., April, 1945, issue.*

Parts Manual

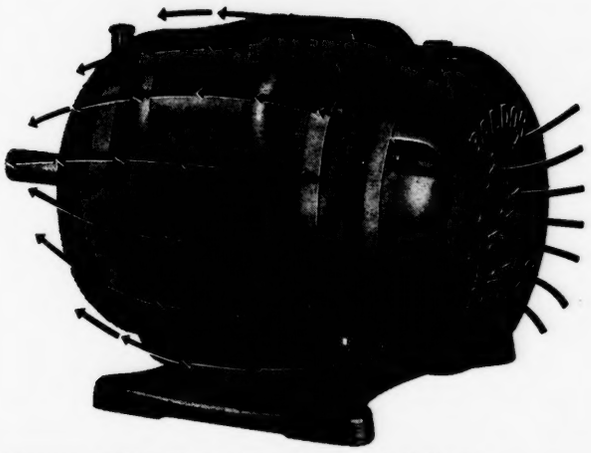
An 8-page, illustrated parts manual to make ordering of Canton stoker repair parts easier. Part names become simple to identify. — *Canton Stoker Corp., 407 Andrew Pl., S. W., Canton, Ohio.*

. . . Since the Last Issue

The Trane Company, La Crosse, Wis., has enlarged its line of propeller type fans to include new models and a greater variety of sizes. Trane propeller fans may now be obtained with either 2 or 4 blade propellers, with direct or belt drive. Sizes of the two-blade fans are 15 to 48 in. diameter. Four-blade fans are from 10 to 72 in. diameter. A new cradle type of fan mounting in a wide range of sizes of either 2 or 4 blade propellers is also being built. All standard fan motors and bearings are available.

THE MOTOR for MANY APPLICATIONS

It's the BALDOR STREAMCOOLED MOTOR



Arrows indicate air travel over ENTIRE EXTERIOR of Baldor Streamcooled motor.

This ALL-PURPOSE MOTOR will simplify your Designing, Purchasing, Production and Inventory. Check these features with your motor specifications:

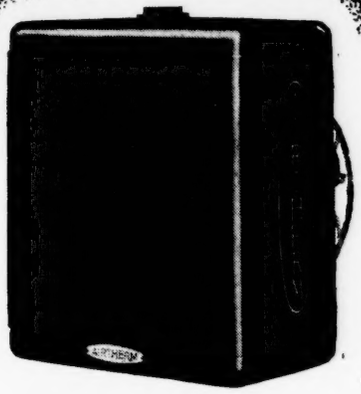
1. Totally enclosed — ball bearing.
2. Drip-proof; splash-proof; grit-proof; lint-proof.
3. Horizontal, vertical and side wall mounting.
4. Removable base.
5. End plates interchangeable for face mounting.
6. Standard NEMA dimensions.
7. Standard or glass insulation.

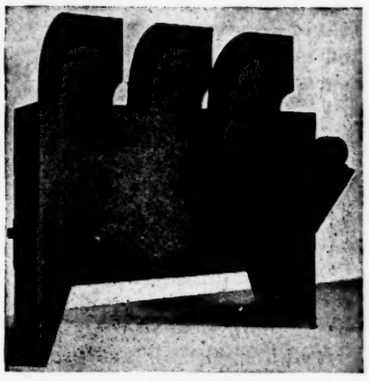
BALDOR ELECTRIC COMPANY, St. Louis 10, Mo.
District Offices in Principal Cities

PLAN YOUR POST-WAR MOTOR REQUIREMENTS ***Now.*** Get the Latest BALDOR Bulletins

---

Plan Now FOR NEXT SEASON'S HEATING REQUIREMENTS





Now is the time to be planning your heating needs for next season. There is an Airtherm Unit Heater to properly, efficiently heat any plant with a saving in fuel.

AIRTHERM PROPELLER TYPE STEAM UNIT HEATERS

Airtherm Steam Unit Heaters are individually controlled. They provide heat only where you want it, and when you want it. They are available in both vertical delivery and horizontal delivery types for ceiling or wall mount.

AIRTHERM BLOWER TYPE STEAM UNIT HEATERS

A high velocity unit which assures uniform temperature distribution and maximum heat flow effecting savings in both fuel and maintenance cost. This Airtherm Unit is suited to duct installation. Capacities range from 216,000 to 825,000 b.t.u.

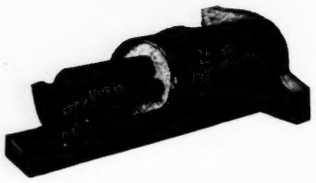
Send us your specifications now. Our engineering department is at your service.

AIRTHERM
MANUFACTURING COMPANY
722 South Spring Avenue • St. Louis 10, Missouri

ADSCO-BANNON TILE CONDUIT

Protects underground pipe lines

NO WORKING IN CLOSE QUARTERS TO PUT PIPES TOGETHER



The split tile construction of Adsco-Bannon Tile Conduit permits threading or welding pipes where you can get at them before laying on the supports.

BASE DRAIN
Carries away ground seepage water. Keeps insulation dry—prevents undue heat loss—prolongs life of the piping.

HIGH THERMAL EFFICIENCY
Unlike illustration at the left, you don't pay for melting snow. In combination with "Fiberglas" insulation, it keeps the heat where it belongs.

MOIST CINDERS AND SLAG CANNOT ATTACK IT
Adsco-Bannon Tile Conduit lasts indefinitely where metals would fail quickly. Bury it and forget it.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, NEW YORK
Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

FEATURES—(*Turbine Type*)

Water-cooled head bearings • Choice of oil or water lubrication • Double Bearings in each bowl • Fully-enclosed impellers • Double Seal impellers.

ARMY NAVY E
PEERLESS PUMPS

Capacities—10 to 220,000 gallons per minute

PEERLESS PUMPS
PEERLESS PUMP DIVISION
Food Machinery Corporation
TURBINE HI-LIFT HYDRO-FOIL
301 W. Ave. 26, Los Angeles 31, Calif. • 1250 Camden Ave. S.W., Canton 6, Ohio • Other Factories: San Jose 5, Fresno 16, Calif.

Rucker-Vaughn Co. has expanded plant facilities and consolidated the sales offices in the new location at 4228 Hollis St., Oakland, Cal. The company provides a full valve maintenance service, in addition to its manufacturing facilities.

The Viking Air Conditioning Corp., of Cleveland has appointed **Mark M. Woolwerth** to the advertising and sales promotion department. Mr. Woolwerth's former associations were primarily in the news writing field. He was connected with the Associated Press in New York and then the Cleveland Press, where he was a general assignment writer. Mr. Woolwerth also did public relations work with the Fisher Body Division of General Motors before joining the Viking organization.

Mark M. Woolwerth

Crane Co., Chicago, announces the appointment of **Lucien W. Moore** as general manager of sales and branch houses, succeeding **J. A. Dwyer**, recently elected vice-president in charge of sales and branch houses. **F. J. Wilkey**, district manager, Chicago was appointed manager of the valve and fitting department, the position occupied by Mr. Moore until his recent assignment in France by the War Department.

Mr. Moore had served the Crane subsidiary in France as manager of sales, and after his return to the United States in 1940 he was successively manager of pipe sales and general purchasing agent, before his appointment as manager of the valve and fitting department. He will assume his new duties on completion of his present special mission for the government.

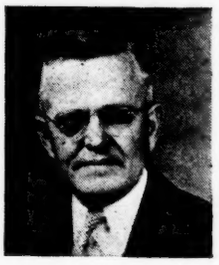
Mr. Wilkey started with the company in the Cleveland Branch in 1929, where he filled various positions before being made manager in 1939. He was promoted to district manager at Cleveland in 1942, and transferred to the Chicago district in 1944.

The Herman Nelson Corporation, Moline, Ill., manufacturer of heating and ventilating equipment, announces that the **J. R. Bradley Co.**, 1 West Plaza, Reno, Nev., has been appointed distributor in that area.

W. B. Connor Engineering Corp., 114 East 32nd Street, New York 16, N. Y., has recently appointed the following in the districts noted to handle Dorex adsorption equipment and Kno-Draft diffusers: Harry A. Pillen Co., 626 Broadway, Cincinnati 2, Ohio; The Allen, Mitchell & Co., 1053—31st Street N. W., Washington 7, D. C.

Oscar E. Swanson has been appointed service manager of the Evanair Division of the **Evans Products Co.**

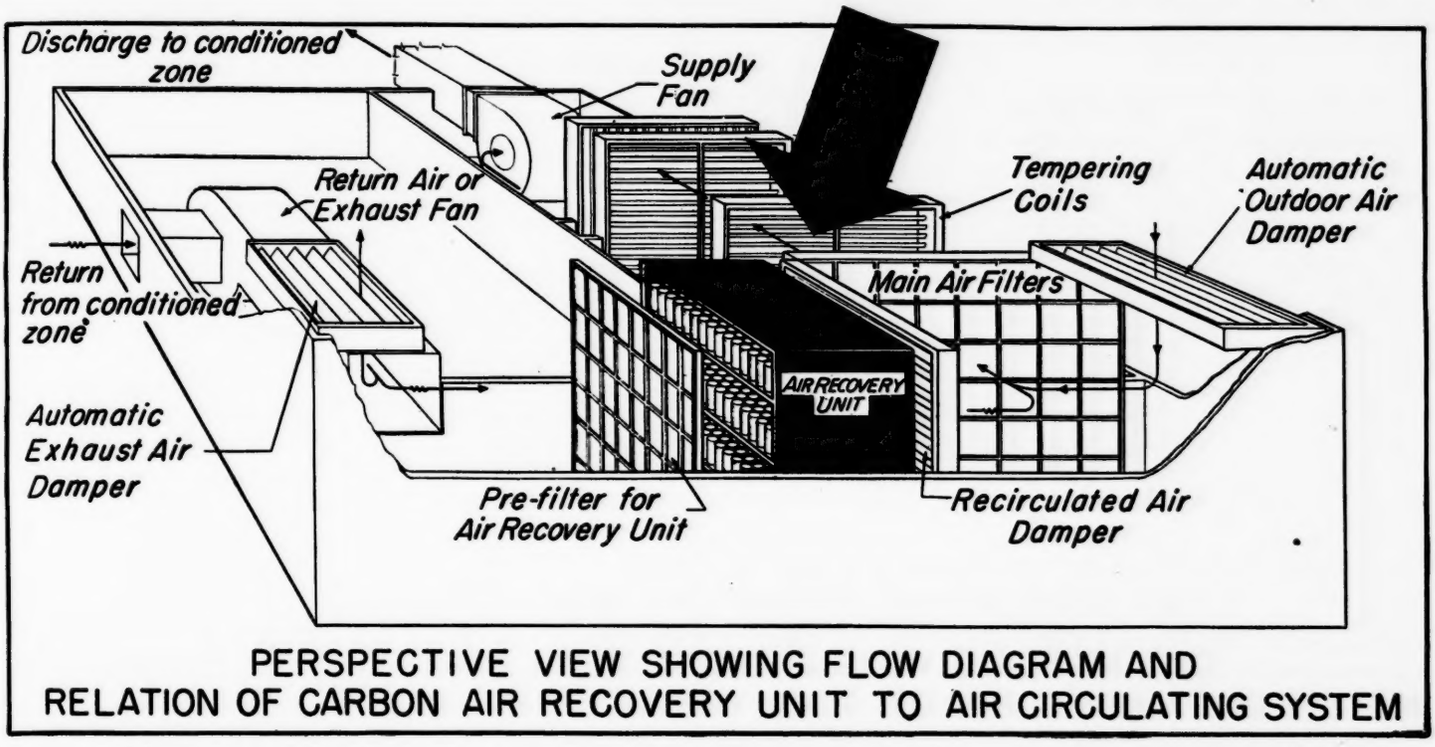
Mr. Swanson, with Evans for the past two years in charge of Detroit service headquarters, spent 15 years with the American Gas Machine Company, mostly as a southern district manager. In that capacity he conducted many service schools and instructed dealers in servicing appliances similar to Evanair heating equipment.



Oscar E. Swanson

Aggressive plans are being made by Mr. Swanson for a nation-wide service organization through Evanair's hook-up with Westinghouse Electric Supply Company in United States and Mexico, and Fairbanks-Morse Company, Ltd., in Canada. A program of service schools is to be held soon in key distributing points in United States and Canada. **Robert F. Hawkins** will be assistant service manager and will supervise directly the service crews in the field.

Columbia Activated Carbon Deodorizes Air and Cuts Air-Conditioning Costs



PERSPECTIVE VIEW SHOWING FLOW DIAGRAM AND RELATION OF CARBON AIR RECOVERY UNIT TO AIR CIRCULATING SYSTEM

(Columbia Activated Carbon used in air recovery unit designed and supplied by W. B. Connor Engineering Corporation)

● Substantial savings in air-conditioning costs are possible when Columbia Activated Carbon is used to deodorize stale air returned to the air-conditioning system.

Because the used conditioned air can be restored to freshness by activated carbon, outside air requirements are smaller. Heating or cooling equipment can be smaller; energy costs for heating or cooling will be less.

You should consider odor removal with Columbia Activated Carbon in every air-conditioning installation and refrigerated storage space. When used in properly designed equipment it efficiently *removes*—it does not mask—all types of odors such as those from foods, cooking, smoke, liquor, and normal human activities. Also, objectionable odors and vapors from manufacturing operations can be eliminated and working conditions thus improved.

Columbia Activated Carbon supplied for air purification was developed after years of research and has proved to be a superior product. It is a hard, dust-free granular adsorbent which can be reactivated and re-used many times. It has a very high capacity for adsorbing impurities and has minimum resistance to air passage. You can get further information on the use of Columbia Activated Carbon for air purification and odor removal by writing us.

If the Neighbors Object . . . . . .
Activated Carbon adsorbers can be used to remove odors from exhaust air systems in restaurant kitchens, sewage plants, slaughter houses, chemical plants, and many other industries where air pollution is a problem.

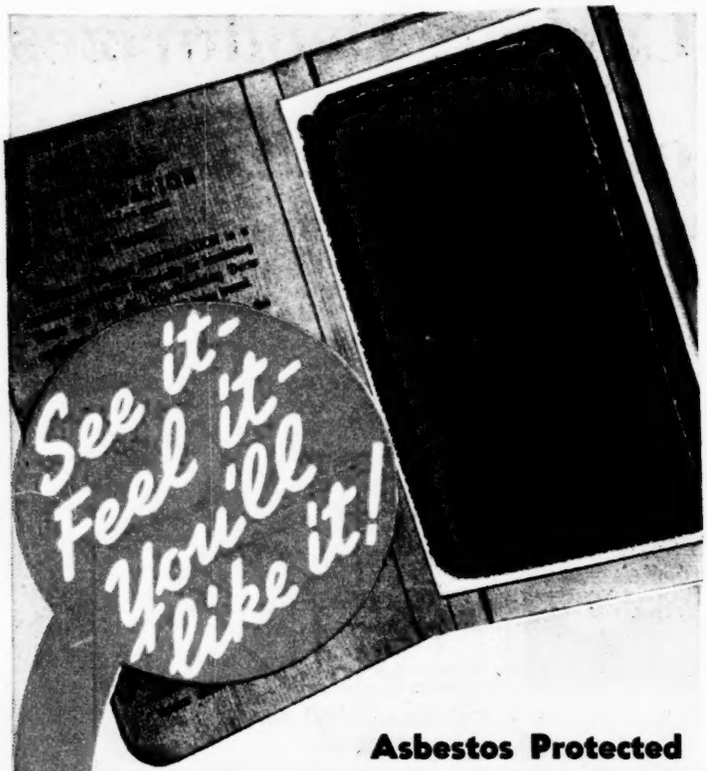
BUY UNITED STATES WAR BONDS AND STAMPS

CARBIDE AND CARBON CHEMICALS CORPORATION
Unit of Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

COLUMBIA TRADE-MARK
Activated Carbon

Life-Saver for Men and Materials

SOLVENT RECOVERY · CATALYSIS · GAS AND AIR PURIFICATION

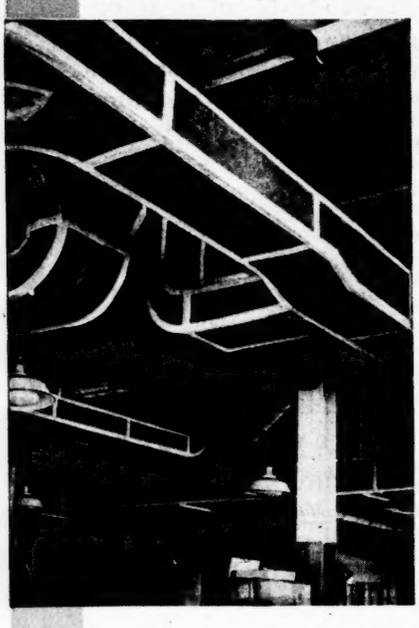


Asbestos Protected

DUX-SULATION

Write for an actual sample of genuine asbestos-protected DUX-SULATION for your inspection and tests. All purpose Dux-Sulation is the nationally accepted Blanket-type insulation for metal Ducts —made especially for the Air Conditioning, Ventilating, and Warm Air industries.

Dux-Sulation does a big job—prevents 75% of your present heat loss, prevents condensation, duct sweating and duct rust. Quiets mechanical and air-borne noises by absorbing 70% of such sound when applied to inside of duct.



Dux-Sulation is a flexible insulating blanket ½" thick having a K. factor .27 B.T.U. Comes complete with corner and joint tape and special adhesive for cementing it on to sheet metal surfaces. Dux-Sulation is 36" wide. A roll contains 100 square feet. Dux-Sulation is easy to apply, easy to handle on the job, and easy to cut and fit.

Asbestos-protected Dux-Sulation is safe. Has low frictional resistance (f=.0001322). Moisture proof surface! Mildew proof treated. Will not chip or flake.

Write us today on your letterhead for our booklet No. 61 containing this attractive actual sample of genuine asbestos-protected Dux-Sulation.

Specify asbestos-protected Dux-Sulation on all your duct work for better performance.

GRANT WILSON, INC.

141 WEST JACKSON BLVD., CHICAGO 4, ILLINOIS

Edward P. Fahey has been appointed division manager of **York-Shipley, Inc.**, of York, Pa., manufacturers of York-Heat.

Edward P. Fahey

Mr. Fahey has a varied background of experience in the heating and plumbing industries, and was a pioneer in the oil-burning field, starting with the installation of oil-burners in Kansas, back in 1911. He is a past-president of the Chicago Oil Burner Association.

Mr. Fahey has held the posts of president of Ray Heat & Power Co., Chicago, and eastern manager for the Ray Oil Burner Co., San Francisco. More recently he has served as a consulting engineer for R. H. Monsell Co., New York; Energy Control Co., New York; and Smukler Plumbing Supply Co., Morristown, N. J.

Clarence H. Schuettenberg has been appointed sales manager of the stoker division, **Link-Belt Co.** He has been associated with the stoker division since 1933 originally as distributor in the St. Louis area, and later as sales manager for one of the company's largest stoker distributors. Recently he has been sales manager for the stoker division in the St. Louis district. His headquarters will be at the Link-Belt Caldwell plant, 2410 W. 18th St., Chicago, where the stokers are built.

Lewis M. Horvath has been appointed divisional sales manager, **HI-G Division, General Controls Co.**, Glendale, Calif. He has specialized in the hydraulic controls field and has recently been for several years with the Adel Precision Products Corp., Burbank, Calif. Prior to that he held executive and design positions with Ford Motor Co., Briggs Mfg. Co., Chrysler, Cadillac and Studebaker Corp. His aircraft experience stems from such firms as Bendix, and Curtiss-Wright.

Utility Appliance Corporation, Los Angeles, manufacturer of heating, cooling, and air-moving equipment, announces the appointment of **Higgins Industries, Inc.**, New Orleans builder of invasion landing craft, as distributors of the complete line for Louisiana, south central Mississippi, and southern Alabama.

Appointment of **P. M. Hutchins** as manager of advertising and sales promotion for **The National Radiator Company**, Johnstown, Pa., is announced. Formerly advertising director of three daily newspapers in Georgia, Mr. Hutchins was associated from 1932 to 1944 with the **Pittsburgh Sun-Telegraph**, in recent years as general promotion manager.

P. M. Hutchins

Howard L. Spindler has been appointed manager of advertising and sales promotion of the **American Radiator & Standard Sanitary Corporation**, succeeding the late Charles B. Nash. He has been associated with the corporation for eighteen years, having served in the Milwaukee, Baltimore and Richmond sales offices.

Major David R. Webster has resumed his duties as sales manager at the **Reznor Manufacturing Company**, Mercer, Pa., manufacturers of gas-fired unit heaters. Major Webster served two and one-half years in the Army, for the past two years as Chief of Administration, Motor Transport Service, Persian Gulf Command.

Which will it be in a highly competitive tomorrow?

EFFICIENT business never has money to burn — a fact that will prove doubly important tomorrow when every expenditure will count heavily in a keenly competitive market.

Yet, while your boiler plant equipment remains outmoded, you may be tossing $10 (or more) out of every $100 paid out for the production of steam, right into the fire. You're simply not securing *full* use of your oil or gas.

That's where Todd Automatic Burners for liquid or gaseous combustion mean the *profitable* difference between high and low-cost steam.

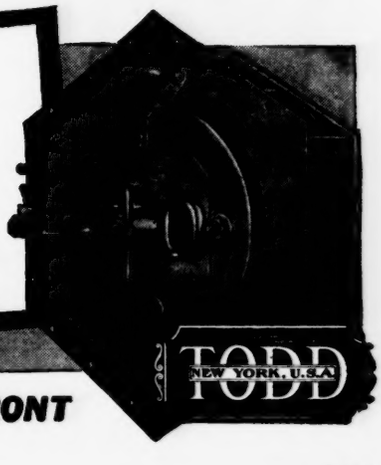
Regardless of the type specified, Todd oil or gas burners actually shave steam production costs up to 10% or better. At the same time, they step up power capacity to maximum and cut maintenance charges to the bone.

For *cheaper* production of power and heat, for industrial or commercial use, you're *combustion-wise* when you *modernize* with *Todd.* Our engineers are at your ready disposal for consultation on your specifications.

ARMY E NAVY

COMBUSTION EQUIPMENT DIVISION
TODD SHIPYARDS CORPORATION
601 West 26th Street, New York 1, N. Y.

NEW YORK, BROOKLYN, ROCHESTER, HOBOKEN, NEWARK, BARBER, N. J., PHILADELPHIA, SO. PORTLAND, ME., BOSTON, SPRINGFIELD, MASS., BALTIMORE, WASHINGTON, CHICAGO, GRAND RAPIDS, TAMPA, GALVESTON, HOUSTON, MOBILE, NEW ORLEANS, LOS ANGELES, SAN FRANCISCO, SEATTLE, TACOMA, MONTREAL, TORONTO, BUENOS AIRES, LONDON



ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

Refrigeration Service Engineers.....

PERFORMING OUTSTANDING MAINTENANCE JOB

Today, in towns all over America refrigeration service engineers are doing an outstanding maintenance job of keeping refrigerated display cases, ice cream cabinets, food storage lockers and the countless other applications of refrigeration running smoothly and efficiently.

On call the refrigeration service engineer performs his task, ofttimes while the city sleeps. Thousands of dollars he has saved retailers, countless thousands of pounds of precious food he has prevented from spoiling.

These men rely on A-P DEPENDABLE Refrigeration Controls. They use A-P DEPENDABLE Refrigeration Controls to help them perform their important task. As many of them write, "I use a lot of A-P Controls and never had one fail me yet."

AUTOMATIC PRODUCTS COMPANY
2462 North Thirty-Second Street
Milwaukee 10, Wisconsin
Export Dept., 13 East 40th Street,
New York 16, N. Y.

A-P Model 205 Thermostatic Expansion Valve. Capacity up to 1 ton Freon.

DEPENDABLE *Refrigerant Valves*

Stocked and Sold by Good Refrigeration Jobbers Everywhere. Recommended and Installed by Leading Refrigeration Service Engineers.

The Clark Manufacturing Co., 1830 E. 38th St., Cleveland 14, Ohio, has made a major change in the nationwide sales and distribution of its steam specialties and fluid controls. During the past 37 years these products have been manufactured by Clark but not marketed under its own name. For this reason, the identity of the Clark company itself has been little known in the field, although the products manufactured by it have been widely distributed.

A change of policy, developed during the past several months and put into action on this date, brings all of the activities of product designing, engineering, manufacturing, sales and distribution under the one roof of The Clark Manufacturing Company. From now on the company's products will be sold as "Clark Fluid Controls".

W. S. Goff, who assumed presidency of the Clark company 18 months ago, announces that the concern henceforth will maintain its individual identity, and that it will deal directly with its distributors and customers on a nationwide scale.

Frederick W. Stierhoff has returned to Harvey-Whipple, Inc., Springfield, Mass., as service engineer on special assignments in the New England area. He is well known in the automatic heating trade throughout the eastern seaboard section, having been associated with oil burner manufacturers in that section since 1930. Before that, he was field supervisor for the Shell Eastern Petroleum Company.

Frederick W. Stierhoff

Stockholders of the **Waterloo Register Company**, Waterloo, Iowa, have decided to discontinue doing business and to dissolve the company. Physical assets of the corporation, which was formed in 1902, including the trade name, have been sold to **Associated Manufacturers, Inc.**, of Waterloo, Iowa, who will continue the manufacture of registers and grilles under the same name as a division of Associated Manufacturers.

Graduation exercises were held on May 15 in the Morrison Hotel, Chicago, for those who completed the course on "Efficient Utilization of Coal" at the Illinois Institute of Technology. The course was sponsored by the Chicago Stoker Dealers Association. Following exercises, at which certificates were awarded to those who had successfully completed the course, a graduation banquet was held in the hotel.

R. C. Gregg has joined the engineering staff of the **Bryant Heater Company**, Cleveland, Ohio. Formerly assistant chief research engineer of the American Gas Association Testing Laboratories, Mr. Gregg obtained his Master of Science degree in chemical engineering from Ohio State University in 1925, and did additional graduate work in chemical engineering in that institution. His experience in testing and research work has included service as technical advisor to various approval requirement committees in the past several years. Mr. Gregg will be engaged in fundamental research work for Bryant.

N. Charlton Gilbert has been appointed industrial relations director for Bryant Heater. Prior to his new connection, Mr. Gilbert was personnel director for the A. C. Gilbert Co., New Haven.

New directors, to fill two vacancies on the governing board of **Indoor Climate Institute**, were elected at the April meeting in Detroit. They are **C. A. Olsen**, president of the C. A. Olsen Mfg. Co., Elyria, and president of Henry Furnace Co., Medina, Ohio; and **Bruce T. Cunningham**, sales executive of Research Products Corp., Madison, Wis.

The sanitary ware plant of the **General Ceramics Co.** in Matuchen, N. J., which has been operated under the name of **Carillon Ceramics Corp.**, has been purchased by the **Richmond Radiator Co. Henry L. Charlton**, president of the latter concern, announced the change.

Henry L. Charlton

The Carillon concern and its predecessors have been engaged in the manufacture of sanitary ware for more than 30 years. Its activities have been devoted exclusively to the production of a complete line of high-grade vitreous china and Perma-Gloss plumbing fixtures. It is the purchaser's intention to make extensive improvements and additions to the Carillon plant as quickly as the lifting of wartime construction restrictions will permit.

The Richmond Radiator Company is a subsidiary of the **Reynolds Metals Company.**

The name of the **Westinghouse Electric and Manufacturing Co.**, has been changed to **Westinghouse Electric Corp.**, effective May 12. This was done for the sake of brevity and simplification.

Sterling, Inc., Milwaukee, Wis., announces the appointment of the following representatives: Edward H. Cox, Buffalo; Bernard Thomas, Tampa; Allonier Engineering, Cincinnati, and Greene Hogg, Louisville. Working closely with the heating jobbers in their respective territories, these representatives will handle the entire Sterling line of heating specialties, heating pumps, automatic radiator temperature controls and process temperature controls.

Maid-O'-Mist, Inc., Chicago, manufacturers of automatic humidifiers and heating specialties, have recently moved their offices and factory to their own three-story building at 3217-19 N. Pulaski Road, Chicago 41, Ill.

L. E. Schulein, 431 S. Dearborn St., Chicago, is representing **Peerless Electric Co.** of Warren, Ohio, in the Northern Illinois territory. The company has recently received the Army-Navy "E" award.

Charles G. Heydon, sales engineer for **Wright-Austin Co.**, Detroit, Mich., died suddenly of a heart attack in the company's New York office May 9. Mr. Heydon was associated with Wright-Austin for 25 years.

Richard A. Angus, previously production manager for **Sunroc Refrigeration Co.**, Glen Riddle, Pa., makers of water coolers, has been appointed sales manager. Before coming to Sunroc, he was for ten years with the Sales Division of the Curtis Publishing Co. New district sales managers are West, **O. E. Zimmerman**; South, **George Morrison**; East, **Marion Dougherty.**

Richard A. Angus

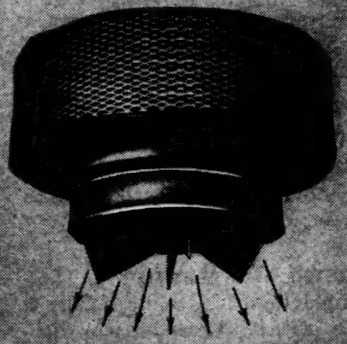
C. S. Trigg and **Paul J. Barnaby** have been appointed to key positions in the Sales Promotion Department according to an announcement by the **Frigidaire Division, General Motors Corporation**, Dayton, Ohio. Mr. Trigg, formerly in charge of Appliance Training, is now manager of Appliance Product Promotion and Mr. Barnaby, formerly of the Commercial Training Department, is manager of the Commercial Product Promotion.

McCORD
HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

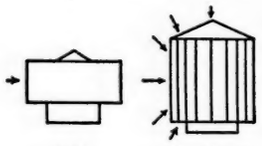
Breidert Air-X-Hauster CHIMNEY TOP

The greatest scientific improvement in Ventilators in over 50 years

TYPE B-2 CHIMNEY TOP

Eliminates smoking fireplaces caused by down-draft

By stopping all down-drafts (interior negative pressure excepted), a Breidert Air-X-Hauster on the chimney absolutely prevents the fireplace from smoking and damaging furnishings. *It provides positive "draw" regardless of wind direction!* Scientifically designed to convert *any* wind current into a powerful suction force, the Breidert remains stationary, has no moving parts. Successfully in use in all parts of the country.

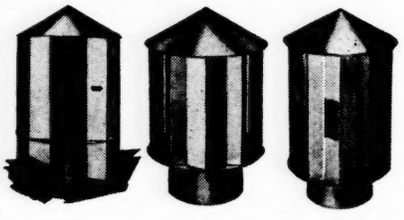


Old Method — Breidert Method

TESTED AND CERTIFIED . . . Thoroughly tested by Smith, Emery & Co. (Pacific Coast branch, Pittsburgh Testing Laboratories) with wind blowing at *all* angles, the Breidert's amazingly high capacities are fully certified.

Breidert Air-X-Hauster Roof Ventilators and Vent Flue Caps

The remarkable ability of the Breidert Air-X-Hauster to provide positive ventilation no matter which way the wind blows, has been proved in thousands of installations throughout the country. Properly installed, the Breidert has *never* failed to fully meet every claim made for it!



TYPE A FOR ROOF VENTILATING — TYPE B — VENT FLUE CAP

WRITE FOR FREE ENGINEERING DATA BOOK . . . containing specifications and installation data, certified capacities, etc. Address Dept. R.

G. C. BREIDERT CO.

634 South Spring St., Los Angeles 14, California

REPRESENTATIVES LOCATED IN PRINCIPAL CITIES OF THE U. S.

The James F. Lincoln Arc Welding Foundation, Cleveland, has announced a project in the form of an award program to encourage the preparation and publication of textbooks, one on machine design and another on structural design for fabrication by all processes, including welding. Awards in the program total $10,000 in each class.

G. M. Rohde, Jr., has rejoined the **Ruud Manufacturing Company,** Pittsburgh, Pa., makers of automatic gas water heaters, as assistant to the president, R. H. Lewis, and will be in charge of special assignments. He was at one time with the Pennsylvania Power & Light Company as supervisor of gas sales and of the electric range and water heater department. Later he was western manager for Roberts & Mander and following that a member of the Ruud-Monel promotion staff. When war came, he was loaned to the Training Within Industry of the War Manpower Commission and subsequently became associated with the Westinghouse Electric & Manufacturing Company as manager of rural electrification at the Pittsburgh, Pa. headquarters.

Frank J. Brandenburg, formerly with May Oil Burner Company, Bendix Radio, and Standard Gas Equipment Company, has joined **Fluid Heat Division, Anchor Post Fence Company,** Baltimore, as a member of the development staff. C. N. Eckhardt, Jr., a 1944 engineering graduate from the University of Maryland, has joined Fluid Heat as laboratory assistant.

The **Pacific Steel Boiler Division,** United States Radiator Corporation has announced the appointment of **Edward F. Hackett** as branch manager of its New York Sales Office, 101 Park Ave., New York City. He has been employed by the corporation since his graduation from the Clarkson College of Technology in 1923 with a degree in Mechanical Engineering.

Ilg Electric Ventilating Co., Chicago, has opened new branch offices in Grand Rapids and Knoxville and appointed new sales engineers in Dallas and Philadelphia. The newly appointed Dallas sales engineer is **Marvin Gardner,** who since 1939 has been associated with the heating and ventilating industry. Before joining Ilg he was the head of the ventilating department of the Ingalls Shipbuilding Corporation, Pascagoula, Miss.

George A. Innes, a resident of Philadelphia, has been appointed sales engineer under C. Warner Smith, manager of the Philadelphia office. His experience includes eight years with Celotex Corporation. Prior to his association with Ilg, he was with The Barrett Division of Allied Chemical and Dye Corp., as engineer on roofing and waterproofing.

The new office in Knoxville is under the direction of **Roy H. Mackay,** who for the past four years acted as associate engineer for the U. S. Bureau of Reclamation, Washington. Previously, he was construction engineer for the Fraser Brace Engineering Co.

J. W. Pulte has opened the new branch office in Grand Rapids. Before joining Ilg, he was field engineer in Western Michigan for the Detrex Corporation, Detroit.

Tenney Engineering, Inc., has moved from its old address in Montclair, N. J., to 26 Avenue B, Newark 5, N. J.

Burnham Boiler Corp., Irvington, N. Y., has announced the appointment of **Frank R. Brophy** as manager of advertising and sales promotion. For the past 7 years Mr. Brophy has been actively engaged in sales and sales promotion work for the company. He has had 20 years experience in the heating business. At present Mr. Brophy is analyzing the promotional possibilities of Burnham's recently announced product, Base-Ray — radiant baseboard panel.

WHAT READERS SAY

Vapor Barrier

E. L. SCHULZ, CARRIER CORP., Syracuse, N. Y.:

In your article "Based on Experience," in the August, 1944, issue of HEATING AND VENTILATING, you show in your sketches the vapor barrier located on the warm side which is correct. However, the warm side, insofar as heat is concerned is not the same side as the warm side when air conditioning is being considered.

Since you state "while condensation primarily concerns the heating system," it therefore is necessary that the question of the location of the vapor barrier should be determined by consideration of weather conditions during the heating season. You also state, "with the exception of a few low humidity or low temperature applications, dry rot is a result of winter operation." This further points out the necessity of correct vapor barrier location during the heating season. As your main concern is in the air conditioning load, which varies with the amount of vapor penetration through the wall, and since a vapor barrier located either on the inside or outside will stop the penetration of moisture into the air conditioned space, the location anywhere in the wall will serve the purpose for air conditioning. Therefore we take exception to your sketches as shown in the article. They show the vapor barrier located on the outside of the building wall.

Since the average air conditioning temperature differential is in the magnitude of 15F and is fairly constant as compared to the average temperature differential of the heating load of 40F, at which it is subject to variations as much as 90F differential, we believe that the vapor barrier location should be determined solely by winter heating conditions.

Samuel C. Fay
Chairman, Application Committee on Mineral Wool, National Mineral Wool Association

S. C. FAY, Cincinnati, Ohio:

I cannot agree with your statement that "the vapor barrier location should be determined solely by winter heating conditions." Such a blanket statement will lead to serious difficulties in many industrial air conditioning and refrigeration installations involving low humidities or low temperatures.

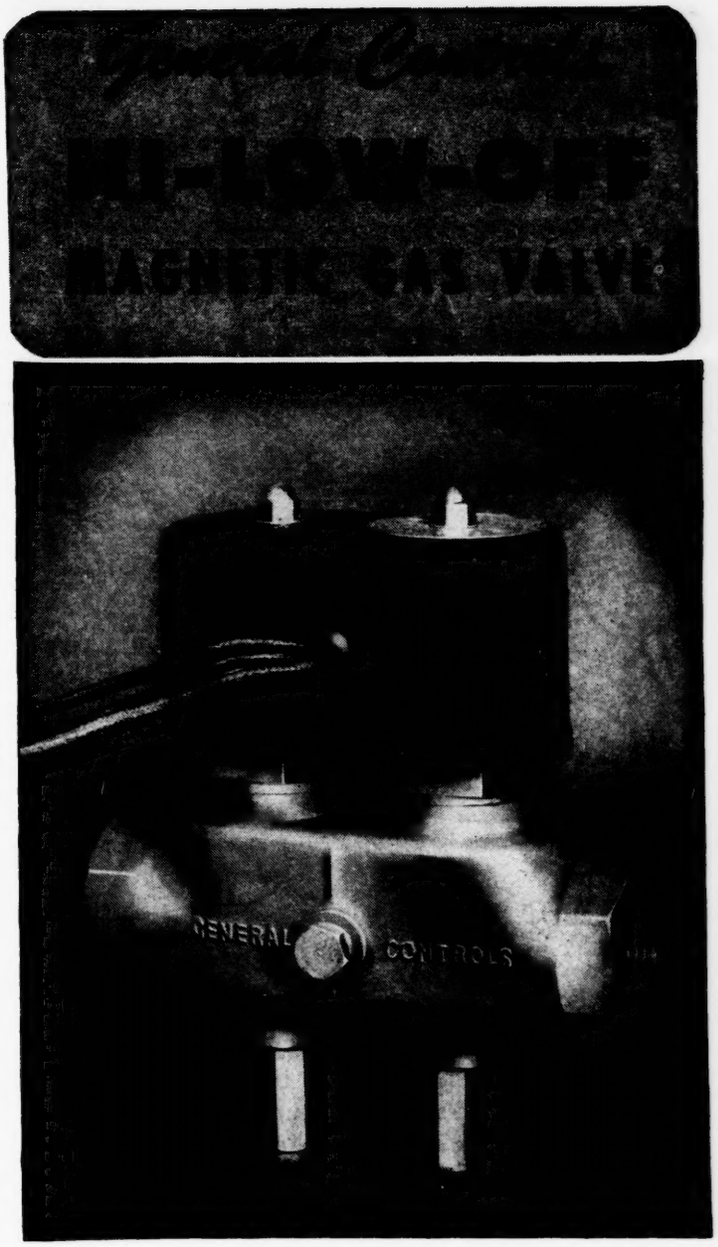
Vapor barriers should be installed on the basis of an analysis of the vapor pressure of the air on both sides of the insulating wall, as well as the dewpoint temperatures that can be obtained at various points through the cross section of the insulation. On this basis all heating and normal air conditioning jobs would require the vapor barrier on the side as recommended by you. However, all low humidity and low temperature jobs would require the vapor barrier installation on the opposite side of the wall.

I regret very much that my statements in the article did not qualify the fact that I was talking only of the humidity and low temperature jobs.

Syracuse, N. Y. *E. L. Schulz, Carrier Corp.*

A Correction

Unfortunately, there is a transposition of Fig. 1 and Fig. 7 in the reference section "A Summary of Design Data for Exhaust Systems," by Allen D. Brandt, on pages 74 and 78 of the May issue. In Fig. 28, the included angle should have been marked *s* instead of the Greek letter theta.



SERIES D-40

D-40 is a current-failure 2-stage electro-magnetic gas valve used on many domestic and industrial applications where hi-low-off control is desired. Thermostatically controlled for constant temperature, low fire is adjustable to minimum flow of 8' per hour. Automatic thermopilots, limit controls, time clocks, etc., may be wired in series with this control, making it applicable to hot air furnaces, conversion burners, gas-fired boilers, etc. Solenoid coils are interchangeable.

HOW IT OPERATES
with Dual Thermostat T-70-6 or 7

Valve opens when energized, closes on current-failure, solenoid wires are color-identified, sequence of operation when used with dual thermostat: Assuming room temperature stands at 60° and thermostat is set at 70°, maximum gas flow is obtained. At 69° high-fire closes, leaving minimum gas flow which closes when 70° is reached. On down cycle, low-fire comes on first at 69° and if low-fire will not maintain heat loss, high-fire automatically comes on at approximately 67½°.

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE 1, CALIF.

FACTORY BRANCHES: PHILADELPHIA • ATLANTA • BOSTON • CHICAGO • DALLAS KANSAS CITY • NEW YORK • DENVER • DETROIT • CLEVELAND • PITTSBURGH HOUSTON • SEATTLE • SAN FRANCISCO • DISTRIBUTORS IN PRINCIPAL CITIES